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CANCER.[1]

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A cancer is a tumor of unlimited growth, which infiltrates and destroys other tissues in its location; particles of which may be transplanted through the blood or lymph channels to other parts where they find lodgment, grow, and form tumors of similar structure to the tumor from which they originated.

It is the capacity for unlimited purposeless growth which makes a cancer dangerous.

It is hard for one to realize the delicate balance which holds our tissues and organs just as they are, while at the same time they are constantly renewing themselves. And yet as soon as this balance is disturbed there must be a wasting or overgrowth of the affected tissue, because every tissue is constantly going through a process of renewal—is rebuilding itself—and it either renews itself exactly as before or there is an over—or undergrowth of it. In cancer we have a disturbance at some definite point which results in unlimited growth of elemental tissue cells—a growth of succulent cells of low resistance in themselves, but that have a vegetative tendency so strong that no barrier in the animal body stops their progress. A capacity for growth is an inherent function of every tissue. This is necessary for repair of damage. If it were not so, every wound of the body would remain without repair. In higher animals this capacity for growth of the tissues does not normally extend beyond the ability to repair wounds by the formation of scar tissue—a man, for example, cannot regrow a lost finger; his tissues will only grow to the point of filling a wound in the finger, or covering with skin the stump of the finger after it is cut off. As you descend in the scale of animal life, you reach animals of fairly highly special-

[1] A lecture delivered in the Popular Course given under the auspices of the Chicago Medical Society, Jan. 28, 1911.

ized structure which can renew a lost member, as, for example, the crab which can regrow perfectly a claw in place of one lost. Going still lower, you find animals of simpler structure such as the earth worm, whose inherent capacity for growth is so strong that cut an individual into parts, and a complete worm may regrow from each part. So this inherent capacity of growth is a fundamental characteristic of tissues, a characteristic, however, which, like many other basic functions of tissues, becomes less distinct the more highly organized the animal.

These variations in the capacity for growth between lower and higher forms of animal life are all passed through in the highly organized animal during his development to maturity. During fœtal life the tissues of the most highly organized animals pass through all of these variations. Throughout fœtal life, growth is the predominantly active function of the tissues, but it is growth restrained by subtle and all-powerful influences that check development when the purpose of the growth is attained. Sometimes its control is not perfect, so that we see occasional malformations and defects of development. But these are very rare and the wonder is, not that they occur, but that in so infinitely complicated a process as development of a living body accidents of growth should occur so seldom.

In cancer we have the reversion of a mass of tissue to its embryonic type, and growth becomes its sole function; but this is not a purposeful growth, controlled and regulated to the needs of the organism. It is an unrestrained, unlimited reproduction of elemental tissue without purpose or use. You can see the dangers of such a situation. A mass of tissue at some point begins an unlimited growth. It has no definite function beyond that of growth, but that is so strong that nothing except its total destruction can prevent it. It invades neighboring tissues and by its very mechanical presence destroys them, leaving in place of tissues with useful, it may be vital, functions to perform, a mass of elemental tissue that cannot take on any of the functions of the tissues that it has replaced, but possesses only its malignant capacity to increase.

A cancer, in short, represents growth of tissues run riot. And like all other things that run riot it damages not only others but itself. In the form of malignant growth to which the term cancer chiefly applies, there is no formation of blood

vessels in the growing mass, and in both forms the blood supply falls short of the demand of the growth for nourishment, so that the very exuberance of the growth defeats its own purpose, blood supply fails, and the cancer tissue in part dies, and ulceration occurs. And here you have the whole sequence of events in cancer; the growth of the tumor destroys normal tissues first, and then through its very avidity of growth destroys itself.

The tissues of the body are essentially of two classes; connective tissue and epithelial tissue. Connective tissue constitutes all of the tissues that are known commonly as "flesh" and includes nearly all of the tissues that make the framework of the body—muscle, nerve, fat, bone, cartilage, blood and lymph vessels, and the stroma that binds all these together. Epithelium is a highly specialized tissue and its chief uses are as a covering or lining membrane, and as the secretory tissue of various organs. It makes the outer layer of the skin, lines the gastro-intestinal tract and the secretory glands of the intestinal tract, and is the functionally active tissue of various organs. All of these tissues may under obscure stimuli exert their latent capacity for growth and form tumors. Tumors of muscle, fat, nerve, bone, cartilage, blood vessels, lymphatic vessels, connective tissue, and epithelium, all occur, many of them frequently. But as a rule these tumors are relatively harmless. Their growth is limited, they are sharply defined and do not grow freely into other tissues and after reaching a certain size, growth ceases and they remain as a mass practically of normal tissue of the same sort as that from which they sprang. They may cause mechanical difficulty by their size, but they do not invade neighboring tissues and destroy them. Such tumors constitute the group that we call benign, and they are very numerous.

The other group of tumors is the cancer or malignant tumors. The malignant tumors of connective tissue origin are called sarcomas; those of epithelial origin carcinomas. In both of these groups the tissue cells revert to embryonic type, and, while attempting to reproduce mature tissues, remain always essentially primitive and never reproduce mature structures as do the benign tumors. Malignant tumors may arise from either of the two great classes of tissues, from the connective tissue or from epithelial tissue. The malignant tumors of these two groups have fundamental differences in development

and characteristic differences in minute structure, so that the division between them is essential. The common features of malignancy, however, which they both show are so much alike that we may make our consideration of one do for both. Sarcoma is very much the less common; about one sixth as frequent as carcinoma; it pursues, as a rule, a most malignant course; and it attacks all ages. These are the most important of the grave clinical differences between it and carcinoma.

Carcinoma, the malignant tumor of epithelial origin, is the common form of malignant growth, and it is the form to which the term cancer is usually applied. Sarcoma is one of the less common diseases. Carcinoma one of the worse scourges of humanity. Henceforth in this consideration of the subject we will confine our attention to carcinoma and use the term cancer as synonymous with it.

Symptoms: Cancer has no symptoms of its own; that is, it has no characteristic group of specific symptoms such as measles or typhoid fever, for example, have. The only invariable symptom of a cancer is the presence of a growth. This may be minute or large; usually it is enlarging but it may be apparently standing still. The symptoms of cancer are practically solely those due to the local disturbance which it produces by its presence in the normal tissues. If it is situated in a vital location it will quickly produce serious symptoms; if in a location where its growth causes destruction of tissues which have no important function its symptoms may be inappreciable. It is a local disease, not a systemic or "blood" disease and its symptoms depend on its location.

In spite of its being a local disease, however, one tumor may be followed by others in contiguous or even distant parts of the body. This is due to the fact that the tumor grows free in the lymphatic spaces, and particles of it may be carried away by the lymph flow. They lodge, as a rule, in the nearest lymph glands and grow into new tumors at their point of lodgment. Particles of cancer may also, but less frequently, be carried by the blood or lymph stream to distant parts of the body, to bones, or the liver, or the lungs, and form secondary tumors there. This tendency to metastasis, as it is called technically, is one of the greatest dangers of cancer and one with which treatment finds the greatest difficulty in dealing. Of course this danger of metastasis varies greatly with the type and location of the cancer. If the rate of growth is slow

there will naturally be much less risk of particles being forced off into the lymph channels than in the case of a rapidly spreading case. And the location is still more important. If a growth occurs on the surface of the body, where it has room to grow outward without resistance, if it is at a site, such as the forehead, center of the cheek, or the scalp where lymphatic connections are least intimate the danger of metastasis may be very remote. If it grows, on the other hand, in a situation where the lymphatics are abundant and connection with lymphatic nodes free, as on the lip, the tongue, or anywhere in the mouth, about the genitals or anus, metastasis into neighboring glands is an immediate and very dangerous probability. With all cancers occurring within the body the danger of metastatic spread is great, but even here there are different degrees of danger. It is this danger of spread of the disease by metastasis that makes early operation in cancer so important. Cancer originates in hardly any structure which is not possible of surgical removal, so that if it can be gotten while confined to this structure it can be taken out successfully. But if left until metastases in other tissues occur it is likely to be so widely distributed that its complete removal is useless or worse.

Visual and palpable characteristics of a cancer depend altogether upon its site. Every cancer begins as a minute growth, and if situated in an inaccessible part of the body may not until late, or may never, become appreciable to touch. In such locations its determination by physical examination requires the skilled hand. On or near the surface the growths show as large or smaller swellings, usually hard and nodular, and it may be with apparently the most innocuous characteristic. Whether a cancer ulcerates or breaks down depends upon circumstances. It may run its entire course to fatal end without ever becoming manifest on the surface to the inexpert or producing ulceration anywhere. When located upon or near the surface either of the exterior of the body or of the cavities, it usually breaks down with the formation of characteristic ulcers.

Changes in General Health: The failure of the general health is likewise a secondary symptom in cancer. It is a common fact for cancer to become well developed in persons of robust health. Patients will offer as arguments against the existence of cancer the fact that they are well, have never

had any blood taint, etc., etc. Such facts are of no importance in this connection. One of the sad features of many cancers is its attacks on strong, useful adults. The disturbance of the general health in cancer comes from the impairment of functions by destruction of important tissues and from poisoning from absorption of septic material from cancerous ulcers. Thus the general symptoms will vary with the location of the disease; one patient will suffer from difficulty of breathing, when the lung is involved; another from disturbance of the stomach, another from symptoms in the lower abdomen, and so on. There is what is called a cancer cachexia, which develops when cancer becomes extensive; the patient becomes pale, anæmic, emaciated, and weak, and this has been attributed to the elaboration of a toxic substance by the cancer cells. But no one has been able to demonstrate such a product of cancer growth, and many patients with extensive growths will go on for months—almost until their deaths—without developing this cachexia, so that it is improbable that there is any such specific poisoning produced by the growth of cancer.

Pain: It may surprise you that pain also is not necessarily a part of cancer. A tumor or cancer is even not tender in itself. Some cancers never cause any pain, and many patients who die of cancer have pain that is only a trivial feature in the sum of suffering that they endure. The pain of cancer, when it comes, arises, from the involvement of nerves which are invaded, and become stretched or otherwise irritated by the growth. When this occurs the pain is severe, it may be agonizing. But the absence of pain in the early course of cancer, is one of its deceptive features. The patient may have some inkling of the trouble but in the absence of pain fails to seek advice.

In this connection reference may be made to the mental attitude of many patients with cancer. It can hardly be called a symptom of cancer, but it is so common that it is a familiar fact with cancer patients. Many of them—most I am tempted to say—try to close their minds to its presence. Many lose priceless months before seeking advice, or, fortunately, do not admit its existence to themselves while making every effort for its relief. It really amounts to a peculiar self-deception, which, except when it interferes with promptness in caring for themselves, is in a way fortunate, for it helps the patients to bolster themselves up and gather fortitude to en-

dure their ordeals. This is beside our subject, but the bravery and patience, as a rule, of persons with cancer give one who comes much in contact with them a better opinion of humanity. As in other real crises in life, people in such situations show their strongest qualities, and rise above the pettiness that mars most of us in the ordinary affairs of life.

Distribution: There are almost no places in the body where cancer may not occur, but there are certain locations that are its most frequent sites. The reason for these sites of preference we will consider in part in considering the causation of cancer. The most frequent location, I am convinced, although this is not shown in general statistics, is the skin. In the skin the most frequent sites are the face, especially the lower lip, and the external genitals or the anus. After the skin the commonest locations, given in the order of their frequency are the female breast, the uterus, the tongue and the mouth, the rectum, the stomach, and other parts of the gastro-intestinal tract.

Cancers as they occur in the skin begin as apparently trivial small growths—a tumor the size of a bird-shot or a pea, or a reddened, scaly, or perhaps, raw patch. Their starting point is frequently some other defect in the skin, as a persistent fissure in the lip, an irritated area, from a collar button, for example, a scaly patch such as is common in old people, a scar or a mole. The character of a beginning cancer requires an expert to make a diagnosis and he may need a microscopical examination. The thing for the inexpert is not to neglect irritated patches or small growths that show irritation, particularly if they are persistent and occur in those past forty. It makes no difference if such places in the skin are apparently not increasing in size; cancers in the skin, fortunately, grow often with extreme slowness—quite contrary to the course in the deeper structures of the body—and they thus offer the most favorable conditions for successful treatment, if only they are taken care of before they have spread so that their entire removal is impossible. What is said about irritated patches and small growths, applies with particular force to such lesions occurring on the lips, especially the lower lip in men, on the tongue, and in the mouth, particularly on the inner surface of the cheeks at points irritated by bad teeth, on the genitals, and at the anus.

There are two deeper locations where much depends upon

early recognition by the patient; these are the breast and the uterus. In both of these organs cancer begins and continues for a long time painless. Cancer of the breast begins as a lump which is not tender on pressure, but may have occasional slight shooting pains in it. There are many other things that cause lumps in the breast besides cancer, but every such lump demands immediate efforts to determine its character. Any lump in the breast should be regarded as suspicious; if the person is under 30 the presumption is against cancer, but there should be no time lost in looking after it, for early cases of cancer of the breast have a good chance of cure, and late cases little or none. The important sympton of cancer of the uterus that should attract the patient's attention is occasional bleeding. Unusual and repeated bleeding from the uterus in women over 35 is a symptom which demands attention to determine its cause. Fortunately it may mean many other things beside cancer.

(To be continued.)

THE CRAWFORD NOTCH SAVED.

The passage by the New Hampshire Legislature of the bill providing for the purchase by the state of the Crawford Notch is a triumph that so far as the state itself is concerned is on a par with the passage of the Weeks Bill by Congress. The Crawford Notch purchase will institute a state policy in harmony with the new national policy that should ultimately make of the White Mountain country a great combined state and national forest, protected from fire, its forest crops carefully husbanded, its scenic values preserved—a never-failing source of health and wealth to the people.

The final passage of the bill in both houses by a unanimous vote would make us wonder at the delay and doubt as to its final success if we did not know the devious ways by which legislatures reach their conclusions. Evidently its friends did effective work, and Governor Bass, whose influence was felt throughout in behalf of the bill, has made himself already a force to be reckoned with. There was objection to the original appropriation of one hundred thousand dollars and as finally passed the amount to be paid was placed at the discretion of the governor and council, a much more business-like arrangement.—*American Forestry.*

TEMPERATURE OF THE UPPER ATMOSPHERE.

It is said that a height 7.5 miles is the highest point at which a recorded temperature was ever secured. This height was reached by a balloon sent up from the meteorological laboratory of Toronto, February 3. When the instruments sent up with the balloon were recovered, it was shown that the balloon burst at 7.5 miles and that the temperature was ninety degrees below zero.

ADDRESS, WITH EXPERIMENTS, UPON SOUND WAVES: THEIR MEANING, REGISTRATION, AND ANALYSIS.[1]

By Dayton C. Miller, D.Sc.

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Sound is the sensation resulting from the action of an external stimulus on the sensitive nerve apparatus of the ear; it is excitable in no other organ of the body, and is distinct from the sensations of any other sense.

Atmospheric vibration is the normal and usual means of excitement for the ear, this vibration being produced directly in some instruments, called wind instruments, and indirectly by the vibration of elastic bodies in other instruments. Physics is mainly concerned with the nature of this external stimulus, and the word sound is often restricted to refer only to this cause of the sensation. Our interest is largely in relation to musical sounds, and the first, more comprehensive definition is preferred, the study of sounds will include an investigation of their mechanical sources in so far as they affect the ear or produce sensation.

If we investigate how many kinds of sensation the ear can generate, we find that, either because of fundamental or acquired distinctions, the ear divides sounds roughly into two main classes, noises and musical tones. Helmholtz's distinction between tone and noise, that one is periodic and the other non-periodic, in the light of recent experiments, seems hardly adequate. Analysis clearly shows that many musical tones are non-periodic, at least in the sense intended; and it is equally certain that noises are as nearly periodic as are some tones. In some instances noises are due to a rapidly changing period, causing non-periodicity; but by far the greater number of noises which are continuous are merely complex and only apparently irregular; their analysis is difficult or impossible. The ear, often because of lack of training, or the absence of suitable standards for comparison, or perhaps on account of fatigue, fails to appreciate the relations between certain sounds, and, resigning its attention, classes the sounds as noises. The study of noises is essential to the understanding of the qualities of musical instruments, and especially of speech; but their study may well be passed till we more completely understand the nature of the apparently simpler, and

[1]Read before the general session of the Central Association of Science and Mathematics Teachers, in Cleveland, Ohio, November, 1910.

much more interesting, musical tones. While actual musical tones may be non-periodic, containing incommensurable partial tones, yet it is probable that the components are individually periodic, and often the entire tone is periodic. We may proceed with the provisional definition that the sensation of tone is caused by a periodic vibration in the air, and to this we are mainly to confine our attention.

The ear, further, receives three classes of sensations from tones, and presumably no more. One of these gives rise to the characteristic of the tone called pitch; this is easily proven to depend upon a very simple condition, that of mere frequency of vibration.

The second property of tone is loudness or intensity, which is not so simple as pitch. For tones of the same pitch, it varies mainly as the energy of vibration, and this is a function of the amplitude of vibration, varying approximately as its square; loudness also varies with pitch, approximately as the square of the frequency.

The third property of tone is much the most complicated; it is that characteristic of sounds produced from some particular instrument or voice, by which they are distinguished from the sounds of the same loudness and pitch, produced from other instruments or voices. This characteristic is called timbre, clang-tint, *klangfarbe,* or, best of all, the idea is expressed by the simple English word quality; we shall use the word quality in this specific sense.

With comparatively little practice anyone can acquire the ability to distinguish with great ease any one of a long series of musical instruments, even when they all sound tones of the same loudness and pitch. There is an almost infinite variety of tone quality; not only do different instruments have characteristic qualities, but different individual instruments of the same family show more delicate shades of tone quality; and even notes of the same pitch can be sounded on a single instrument with qualitative variations. The bowed instruments, of the violin family, show this ability in a marked degree. But no musical instrument equals the human voice in the richness of qualitative varieties and variations; speech employs these very qualitative varieties to distinguish the letters and syllables.

When we inquire as to the cause of tone quality, since pitch depends upon frequency and loudness upon amplitude, we conclude that quality must depend upon the only remaining prop-

erty of a periodic vibration, namely, the peculiar kind or form of the motion; or, if we represent the vibration by a curve or wave line, the quality is dependent upon the peculiarities represented by the shape of the wave. There is possible an endless variety of motion for the production of sound, and quality is, therefore, almost infinitely complicated in its causes, as compared with the other two properties of sounds.

There cannot be a simpler mode of vibration than that known as simple harmonic motion, which is represented by the wave line called the sine curve; such motion is often referred to as pendular motion.

Sound waves in air are waves of compression, in which the vibratory motion of the particles is longitudinal, that is in the direction in which the wave is being propagated. The motion of the particle is the same as that of the particle in transverse waves; a longitudinal wave may be transformed into a transverse one, and *vice versa,* by a simple rotation of the motion of each particle, as is clearly shown by the wave machine (demonstration). A longitudinal sound wave may therefore be represented for purposes of study and analysis by a curve similar to that which represents a tranverse wave.

Tuning forks properly constructed and mounted on resonance boxes are shown by analysis to produce vibrations in the air which are single simple harmonic motions; the resulting tones are called simple tones, and their sensation is markedly simple and pure. If several simple tones of different pitches, as from several tuning forks, are simultaneously sounded, they simultaneously excite different systems of waves, which exist as variations in density of the air; the resulting displacements, velocities, and changes in density of the air are each equal to the algebraic sum of the corresponding displacements, velocities, and changes in density which each system of waves would have separately produced had it acted independently. There must, therefore, be peculiarities in the motion of a single particle of air which differ for a single tone and for a combination of tones; and in fact the kind of motion during any one period is entirely arbitrary, and may indeed be infinitely various.

As already intimated, every sound which has a distinct quality is a composite sound. Helmholtz has shown that the tone emitted by a single string may have eighteen component tones, while our analyses have demonstrated the existence of at least twenty-six components in the tone of the clarinet. Such a tone is of

rich quality, considered musically. (An experiment was performed, compounding ten simple tones into one resultant tone, illustrating the composite character of the ideal musical tone.)

It may seem strange that one source can emit several tones at one time. But experiment easily shows that a string may vibrate with many different frequencies, producing a continuous series of tones whose frequencies are as the numbers 1, 2, 3, etc. Experiment also clearly exhibits to the eye that several of these different vibrations coexist, while a careful analysis by the ear, aided by resonators, has shown at least eighteen components. (The production of ten different tones from a single air column, and the coexistence of some of these, was demonstrated by experiment.)

The method by which the ear proceeds in its analysis of tone quality was first definitely stated by Ohm, in Ohm's law of acoustics. Helmholtz states this law in the following form:

"Every motion of the air which corresponds to a composite mass of musical tones is capable of being analyzed into a sum of simple pendular vibrations, and to each such simple vibration corresponds a simple tone, sensible to the ear, and having a pitch determined by the periodic time of the corresponding motion of the air."

The separate component tones are called partial tones, or simply partials; that partial having the lowest frequency is the fundamental, while the others are overtones. However, it sometimes happens that a partial not the lowest in frequency is so predominant as to give the main character to the whole sound, and it may be mistaken for the fundamental. If the overtones have frequencies which are exact multiples of the frequency of the fundamental, they are often called harmonics; otherwise they may be designated as inharmonic partials.

Fourier has shown in a purely mathematical way, and with no idea of acoustical application, that any given regular periodic function can always be expanded in a trigonometric series of sines and cosines, and for each case in one single way only. Each sine or cosine term in the series may be considered as representing a single vibration; then in Fourier's series, the successive terms have frequencies which are exact multiples of the first, but the amplitudes and phase differences are arbitrary and can always be found in every given case, by peculiar methods of calculation which Fourier has shown.

In order that sound waves may be analyzed in accordance with

the principles stated by Ohm and Fourier, it is necessary to have a record of the sound wave, that is, to have a curve which corresponds to the peculiar motions of a particle transmitting the sound. No adequate methods for making such records had been known, and elaborate experiments have been made to develop a method by which photographic records showing accurate detail can be made.

The sound to be recorded is concentrated by a horn upon a diaphragm; the motion of the diaphragm is communicated to a minute mirror. Light from the electric arc falls upon the mirror and is reflected to a moving photographic film in a special camera, producing the record of the sound waves. A magnification of about 2,000 is commonly employed; the film moves at the rate of fifty feet per second, and in some cases the spot of light has a velocity on the film of 1,000 feet per second. (The vibrator for photographic recording was exhibited.)

A similar apparatus of larger dimensions may be used in connection with the projection lantern, to show sound waves on a screen to an audience. (Demonstrations were made with a projection apparatus, showing sound waves from various musical instruments, vocal sounds, and speech curves.)

The records of sound waves may be analyzed by numerical methods, but this is very laborious. A harmonic analyzer, which is a kind of mechanical integrating device, may be used with great convenience; it is only necessary to trace the curve with a pointer attached to the recording device, and then to read from a series of dials the numerical data which determine the separate simple components of the complex wave. (Such an analyzer was exhibited. A machine was shown, in process of construction, the purpose of which is to draw the composite wave corresponding to any specified set of components.)

The methods described are being used in an elaborate study of the nature of sounds from various sources; but, while many photographs have been taken and analyzed, the work has not yet progressed so far as to warrant a report in regard to it.

SHOULD THE CONTENT OF HIGH SCHOOL PHYSICS BE CHANGED?[1]

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I have no apology to offer for the infliction of this paper at this time and in this place. As its purpose is primarily to call attention to the subject, it lays no claim to infallibility of diagnosis or to cock-sureness of remedy. Its author has no cry of alarm to sound or song of lamentation to sing on this occasion. He is of the opinion that high school physics, as taught to-day, is reasonably satisfactory, and believes that much credit is due and should be given those who have been instrumental in making it so, through their text-books. But this is a period of unusual inquiry into educational affairs. The question mark is being placed to-day before as well as after many of our high school subjects, and educators are not only asking what this or that subject is good for? but why it is in the curriculum? High school subjects, it would seem, are to be called upon to give an account of themselves and to prove in the crucible of modern educational analysis that they offer something which is really vital to the educational development and future lifework of the child. In this evaluation of high school subjects, physics has nothing to fear. It is all that could be asked for from the standpoint of a general preparation for living, and it stands out conspicuously, among all the high school subjects, when looked at from the standpoint of vocational leaning. It would seem then that, so far as this testing out matter is concerned, physics is already assured a place in the high school education of the future.

One versus Many Courses.

Since the future outlook for high school physics is so promising, we are at liberty to give all our attention to the improvement of its content. But is there a real need in this direction? The experiment, which is now going on, of teaching physics to boys and girls in separate classes, and the introduction of a new text-book, printed in two parts and written from a new viewpoint, indicates that there is. Unless a change in content is made, it looks as though high school physics would become a hodge-podge affair, cut up and patched up in all sorts of ways to meet all sorts of differences and lines of cleavage. While we may

[1]Read before the Physical and Chemical Conference of the Michigan Schoolmasters' Club March 31st.

not be in sympathy with this cutting and patching business for the purposes mentioned, we can easily recognize the cause from which it springs—the growing need of a changed content. But are we going to meet this need by offering different courses to different groups of students, as is being done now in segregated classes and in classes for the stay-at-home and the going-to-college students? Such a method offers relief in spots, but, as its application would be so limited, it should not be considered seriously as a solution of the problem. Would it not be much better to offer a single course that would suit the needs and conditions of eleventh and twelfth grade students, boys and girls, stay-at-home and going-to-college students, alike? Such a course could be used in all our high schools and would have the added advantage of retaining all the benefits in education derived from differences of sex, temperament, and ability. But is such a high school course in physics possible? So far as I can see, there is only one thing that stands in the way, and that is the demand of the colleges and universities, either real or implied, for more work than such a course could offer. But why should our colleges and universities demand more than average high school students are able to do? Would they not display more educational wisdom and get better results if they were to accept work more in keeping with high school conditions? Since our high schools are the colleges and universities in which most of our boys and girls are to complete their formal education, why should not they set metes and bounds to their own work? Believing that they should do so, permit me now to call your attention to some of the changes in the content that I deem advisable.

Quantity Reduced.

In the first place, I think the content should be reduced in quantity. In this connection I wish to call your attention to the fact that, while there has been no noticeable increase in the ability of high school students to do their work, there has been a decided increase in the amount of material placed in our text-books, during the last decade. Carhart and Chute's Elements of Physics, which was the principal text-book used in this state a decade ago, contained 374 pages; while their High School Physics, which is in general use to-day, contains 417 pages, or about ten per cent more matter. Some of the other text-books in physics, which have received and

which are asking for recognition in our state, have the following to their credit along this line: Mann and Twiss' has 283 pages in Part I and 400 pages in Parts I and II; Adams' has 467 pages; Gorton's, 472; and Millikan and Gale's, 483. Most of these books are printed with ten and twelve point type and on pages that are five by seven inches in size. Do they contain too much material for a high school course in physics? I think they do, and I base my conclusion on my experience in teaching the subject from the Carhart and Chute text-books, which compare very favorably with the others from this standpoint of quantity. I am fully convinced of the fact that three hundred pages, of the size above mentioned and all printed with twelve point type, would be a more suitable and satisfactory quantity for a high school text-book in physics. Of course, I am aware of the fact that this would mean a heavy cut in quantity, amounting to from twenty-five to forty per cent in the cases above mentioned. But does not this cut seem desirable and necessary, when we consider the matter from the standpoint of the high school student's time and capacity? Let us look at the matter from this angle for a few moments. Most of our high school students have lessons to prepare in four subjects, and so they must divide the energy which they give daily to the preparation of their lessons into four parts. With their energy so divided and with their capacity for work limited by their years, would not two pages, of the size and type above mentioned, seem enough for their day's work? I find that, when I give about two pages a day, nearly all of the students are able to do the work well; but, when I give more than that, only a few do the work well, while many just manage to pass. We should not forget that the pages of physics are filled with new ideas, words, and diagrams, and that every lesson opens up new lines of thought and experience that add to the confusion and bewilderment of the student, and so should not make the lessons too long. Again, the course in high school physics is generally given in one school year, and so, if that school year consists of ten months, as it generally does, it is given in two hundred days. But from the two hundred days we must subtract the following approximate losses: fifteen days for opening and closing the work of the different semesters; five days for legal and other holidays; twenty days, or about one every two weeks, for reviews; and ten days, or about one every month, for written lessons. This leaves about one hundred and

fifty days in which the teacher can develop new work and assign the same for preparation. In schools having less than ten months the number of days would be correspondingly reduced. It would seem, then, that under the most favorable conditions high school physics has to be presented in about one hundred fifty lessons; and, therefore, if two pages such as I have referred to furnish enough material for each lesson, it follows that high school text-books in physics should contain, as I have before suggested, about three hundred pages. Of course there are some who contend that it is a good plan to put in a text-book more than the student is expected to do—leaving to the discretion of the teacher the omission of this or that as circumstances demand. But is it good educational practice to set tasks for our students that are beyond their time and capacity to execute? Should not the task and the time and capacity of the student be made to correspond? I can see no reason why high school physics should be so bulky that it has to be nibbled at in spots and studied in such a hit and miss sort of way. Because Spencer defined science as he did is no reason why we should crowd every last detail of organized knowledge in the realm of physics into our text-books. Would it not be better to offer a course so reduced in quantity that it would be more in keeping with the ability of high school students to understand and accomplish?

Illustrations Increased.

In the second place, I think the content should be more profusely illustrated. We should appeal to the eye more generously in our efforts to instruct and inspire the child. The illustrations would not have to be large in order to be effective, and I am of the opinion that several could be placed to advantage on each page. These illustrations should consist of diagrams, explanatory of the work under consideration; pictures of scientists and others, alongside the work bearing on their contributions; and diagrams and pictures of the things referred to and made use of in applying the facts, laws, and principles of the subject. By all means let us make a more generous use of this valuable aid in teaching.

Quality Practicalized.

Lastly, I think the content should be changed in quality. I do not advocate a change of quality, however, for the purpose of making the subject easier, for I believe that our students could do the work, if they had plenty of time. But, without running

any risk of making the subject the easiest one in the high school curriculum, I am sure many desirable changes could be made. The tendency in high school education to-day is unmistakably toward vocational training, and, as physics is so well adapted for this kind of work, we should make a special effort to bring it into conformity with this newer ideal. By changing the content of physics, could we not bring its wonderful wealth of information (that wealth of information which makes the civilization of to-day so much superior to the civilization of the past) within the reach of more of our high school students and so help them to prepare, in a larger way, for vocational service? If the content were reduced in quantity, as I have suggested, it would naturally improve its quality, for it would result in the selection of only the choicest and most suitable material for the work. The retention or rejection of certain material would depend largely upon the after use to which it could be put by the student. The colleges and universities could easily and should adjust themselves to a preparation without the absolute units, if their elimination was found desirable. The main thing to work for is a content that would be more directly connected with the life interests of the child. Is it not an embarrassing fact that our students of physics complete the subject and yet know scarcely anything about the physics of a stove or furnace, or the ventilation of a house or public building? Very few of them would know anything about the switches, fuses, wires, and fixtures that would be needed if they were going to build a house and wire it for electricity. And I doubt if one in a hundred could figure out the cost of running a sixteen candle-power electric lamp for an hour, if given the cost of electricity per kilowatt-hour. Why should this be so? Certainly this kind of material would not only give valuable information, but helpful training as well; and would it not furnish good material also from which to select the content of a high school course in physics? Why should not our high school students, when studying electricity, for example, have the matter of switches, fuses, insulators, wires, and lamps brought to their attention, and why should not these things be studied both from the text-book and from samples as well? Why should they not, in the class, at least, and if possible in the laboratory also, measure the pressure and the current used to operate a sixteen candle-power electric lamp, determine its wattage, and what it would cost to operate it for an hour? If time permitted, why should they not be allowed to measure

the candle-power of the light and determine the cost of operating the same per candle-power hour? If the candle-power, rate of consumption, and cost of gas were previously determined, while studying light, the relative cost of the two methods of lighting could now be compared and the student given valuable information as well as valuable training at the same time. But why take more of your time to multiply examples? Practically all of the content could be brought to the same practical basis. Would it not be worth while to make the change? And would not physics, when so changed, become a more vital subject in high school education than it is to-day?

AN ARCTIC COAL MINE.

According to *Le Nature*, the most northerly coal mine in the world is that of the Arctic Coal Company (an American concern) at Advent Bay, on the east coast of Spitzbergen. The coal crops out at the surface of the ground several hundred feet above sea level, and is brought down to the harbor by a funicular railway. The company has about a hundred and fifty men at work, chiefly Norwegians, who remain on the spot all the year, although Advent Bay is blocked by ice and inaccessible to vessels for eight months, viz., from November to June. About six thousand tons were taken out last year, but the maximum output has not yet been reached. The chief market for this coal is Norway, which has no coal mines of its own.

VARIETIES OF MINERAL WATERS.

Various schemes for the classification of mineral waters have been proposed, but none is altogether satisfactory. The substances a water may contain are many, the exact relations between these substances in solutions so dilute, as most natural waters are not known to the chemist, and the possible gradations of mineralization are infinite. These reasons and the additional reason that all the waters in any one class in any scheme of classification yet proposed would not necessarily have the same physiologic action, and hence the same medicinal value, cause the devising of a scheme of classification that will fit all needs to seem impossible. A further matter that may prove of importance in this regard is the occurrence of that unstable element, radium. Radium emanation has been detected in many spring waters, and the presence of the element may explain the cures wrought by some waters that were regarded as only a little mineralized. The radioactivity of a water rapidly decreases, and it is possible that this fact explains why some medicinal waters have greater efficacy when fresh than when they have been bottled for some time.

AN APPARATUS FOR THE STUDY OF THE GAS LAW.

By Henry A. Erikson, Ph.D.,
University of Minnesota.

The object in designing the apparatus described below was to meet a need in the college laboratory, of a simple and compact instrument that will enable the undergraduate to study with a fair degree of accuracy the relation expressed by the gas law PV=RT.

Description of apparatus.—The gas is enclosed in a glass tube 15 cm. long and 1.5 cm. outside diameter, as shown at A in Fig. I. Inside this glass tube and projecting up through the mercury is a steel rod 25 cm. long. This rod throughout its length has threads of one millimeter pitch, is finely pointed at its upper end, and has a micrometer head of 100 divisions at the lower end. The mercury in contact with the gas in A communicates through a rubber tube with the mercury contained in the parallel glass tube B. The glass tube A is surrounded by a glass jacket filled with water which may be heated by passing an electric current through a coil of five turns of No. 24 IaIa wire wound on the stirrer E. The current may be obtained from the house circuit, using a bank of incandescent lamps L connected in series with the coil of the stirrer. As the lamps in the bank are in parellel the current may be altered by connecting or disconnecting the various lamps. All metal parts coming into contact with mercury are of steel and those that come in contact with the water in the jacket are of brass. All packings are of leather. The apparatus is supported by two parallel vertical rods 1.5 meters in height and having a tripod base.

Readings.—The volume of the gas is obtained from the micrometer reading when the point of the rod is even with the mercury surface in A, an adjustment that can be made with great accuracy. The volume V when the micrometer is at zero on the scale and the volume per unit length (k) are given from the calibration to be described below. The pressure in centimeters of mercury height is the barometer reading plus the difference in heights of the mercury surface in A and in B. This difference is obtained from the scale C. The slide D carries a vernier and a mirror upon which is an index line which may be placed, free from parallax, even with the mercury surfaces or, in the case of the tube A, even with

the lower end of the rod R. The temperature is obtained from a thermometer suspended in the water surrounding the tube A.

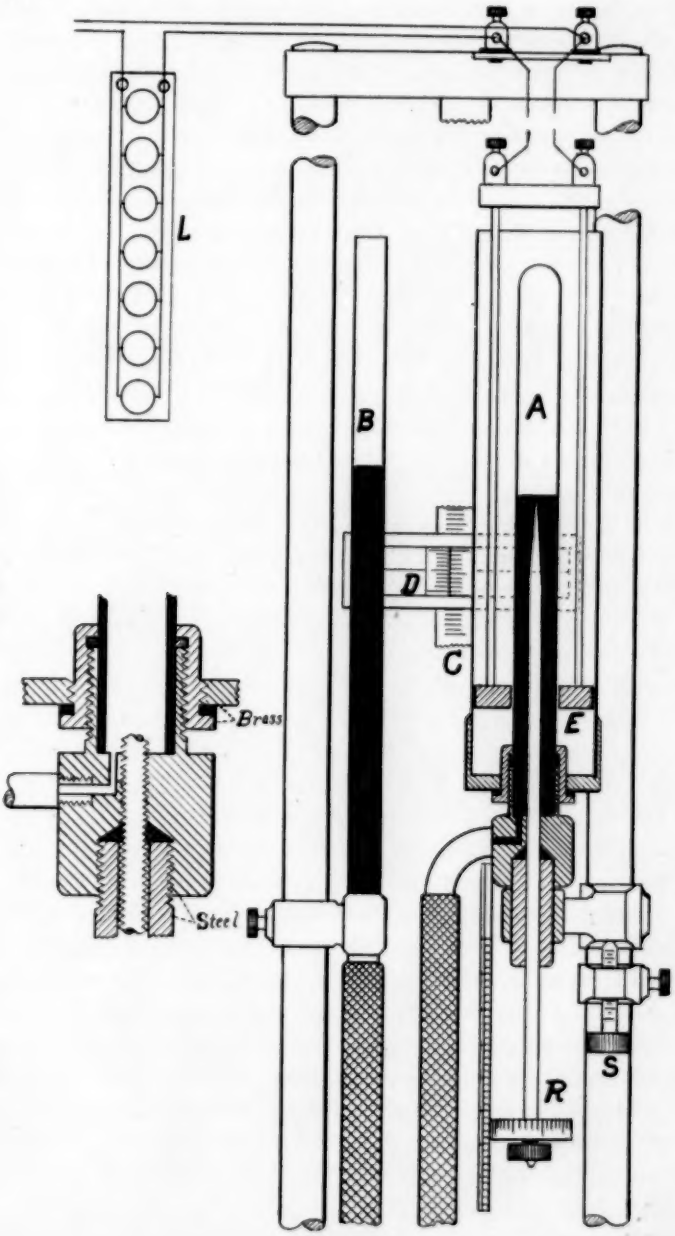


FIG. I.

Calibration.—The volume per unit length of tube A is obtained, once for all, in the following manner: Remove the rod R and clamp the tube A in an inverted position. Pour in a small quantity of mercury. Replace the rod R and obtain the micrometer reading when the point of the rod is even with the mercury surface. Remove the rod and add a known weight of mercury, sufficient to nearly fill the tube. Replace the rod and obtain the micrometer reading as before, noting also the temperature of the mercury. From the weight of mercury, the density of the mercury at the recorded temperature and the difference between the micrometer readings, the volume (k) per unit length of tube may be determined. The volume for a given micrometer reading may be determined as follows: Remove the rod, hold the tube in an inverted position and admit a quantity of mercury. Replace the rod, close the side tube by means of a screw provided for this purpose, place the apparatus in an erect position, and then turn the rod until the point is even with the mercury surface. Obtain the micrometer reading and weight of mercury and tube. Remove the rod and fill the tube completely with mercury, noting its temperature. Replace the rod and turn until the micrometer reads the same as before, the excess of mercury being allowed to escape through the side tube, and weigh. From the difference between the two weights and the density of the mercury at the observed temperature, the volume corresponding to the micrometer reading may be determined. From this volume and the value of (k) the volume V corresponding to the zero of the micrometer scale may be obtained.

Boyle's Law, PV=C.—The temperature of the water in the jacket is kept constant. The volume corresponding to different pressures is determined as given above under "Readings." From these the constant C is computed.

Charle's Law, P=KT.—The micrometer is kept constant. The apparatus is raised or lowered by means of an auxiliary screw S until the mercury is even with the point. The pressure and temperature are then determined. The temperature is then raised by passing a current. When the desired rise has taken place (say 5°) the current is reduced so as to keep the temperature constant. The pressure and temperature are determined as before. From these the constant K is computed.

Boyle's and Charle's Laws combined, PV=RT.—The pres-

sure, volume, and temperature are determined as stated above. In order to increase the range the tube B is raised and lowered arbitrarily during the experiment.

In the hands of the undergraduate student this apparatus has been found to give results agreeing to 0.1 per cent.

In the above the expansions of the glass, mercury, and rod have been disregarded, these corrections being beyond the scope intended. By making these corrections, which may be done with comparative ease and accuracy, more exact results may be obtained. The coefficients of volume and pressure expansion may then also be determined and may be assigned as advanced problems.

A DOUBLE AIR THERMOMETER.

By Thos. E. Doubt,
Armour Institute of Technology.

Those who have worked with the Regnault type of constant volume air thermometer know from trying experience how liable it is to breakage. For advanced students or those engaged in special investigation this is not a matter of great importance. But for the instructor in high school or college who has large classes and thinks it very desirable that the student should gain an intimate knowledge of the effects of heat upon gases, the frequent repair and consequent loss of time to both student and instructor are matters for serious consideration.

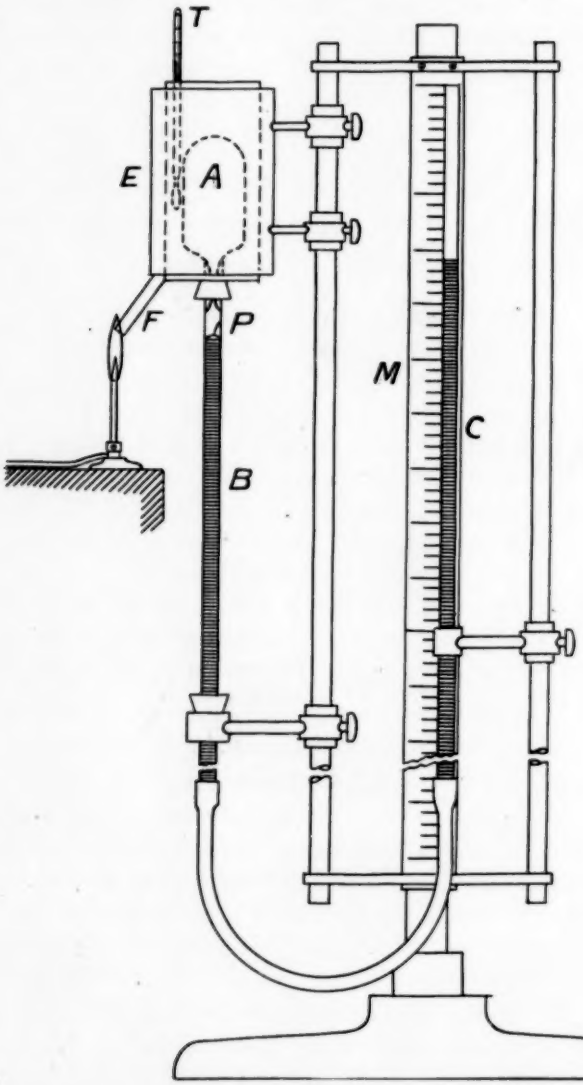
It is with the idea of furnishing a design for a useful and inexpensive instrument not subject to breakage that the following description is offered and not with the notion of presenting much that is original.

Description of the Constant Volume Air Thermometer.

The cylindrical glass bulb A of about 400 cc. is sealed to the tube B by means of a portion of capillary tubing P. The outside diameter of B and P is uniform to where it is sealed to A. C is connected with B by a flexible tube and is movable along the scale M, upon which the readings for the height of the mercury column are taken. The bulb A is enclosed in a copper tank D which is covered with felt E to prevent radiation. The tank is heated by a Bunsen burner applied to the extension pipe, F. T indicates a thermometer for taking the temperature of the bath surrounding the bulb A. The volume of air in the bulb A is kept

constant by adjusting the height of the tube C so that the mercury in the tube B remains in contact with the enamel glass point at P.

If one has the older type of instrument it may be seen at a glance how to reconstruct it at slight expense. The bulb A and the connecting glass tube B can be secured from a glass worker for about two dollars. The important item is to see that the region around P is well annealed. In one instance the tube was



broken three times before mounting but since assembling it has been in use continuously by regular students for over two years without accident.

When the air in the bulb is dry and the mercury clean very consistent and accurate results may be obtained with this instrument without excessive care. An instruction sheet somewhat like the following might be furnished the student.

Fill the metal jacket with cracked ice or with cold tap water. Suspend two mercury thermometers reading 0-100 in tenths of degree from a ring stand by means of wire, placing the thermometer bulbs close to the bulb of the air thermometer. Read the barometer, the top of each column of mercury, and both thermometers. The water in the jacket may be heated to any temperature below boiling by applying the flames of a Bunsen burner to the extension tube. Adjust the surface of the mercury in B to just touch the point P.

Take readings for 10 degrees as the temperature is rising and also while the temperature is falling. Stir the water in the jacket thoroughly before each reading.

Plot a curve with the temperature as abscissas and the pressures as ordinates and extend the curve until it intersects the X axis. The point of intersection indicates the temperature at which the air pressure would become zero if it continued to decrease uniformly. This is called the absolute zero of the air thermometer.

The pressure of the air, p_1, at the temperature t_1 is given by the equation $p_1 = p_0\ (1 + at_1)$. P_0 is the pressure of the air at 0° C and a is the pressure coefficient of air at constant volume. Similarly $P_2 = P_1\ (1 + at_2)$. By eliminating P_0 from these two equations a, the coefficient of air pressure at constant volume may be found.

$$a = \frac{p_2 - p_1}{p_1 t_2 - p_2 t_1}$$

Calculate the value of a for each pair of readings. Find the average value of a and the per cent variation of each value of a from this average.

What would be the effect of the presence of other gases, or of moisture upon the value of a?

What is the effect of the expansion of glass upon a?

How could you correct for this?

TEACHING THE BASIC PRINCIPLES OF APPLIED CHEMISTRY TO HIGH SCHOOL BOYS AND GIRLS.[1]

By C. F. Gustafson,
Manual Training High School, Kansas City, Mo.

In view of the fact that chemistry, dealing with the fundamental characteristics of matter and energy, is at the basis of the natural sciences and therefore also basic to an understanding of those things which concern our daily existence and activities, how are we to account for the fact that greater importance is not attached to this science in the high school?

From parents and others who have themselves high school or college credit for elementary chemistry we hear the remark, "Chemistry may be all right for boys, but why should girls waste their time with it?" More significant still is the assertion made to me recently by the head of a large chemistry department in a school whose specific duty it is to emphasize the application of school training to practical affairs, namely, that a course in chemistry can have no practical value to boy or girl unless it extend through at least two or three years' work. Again, the head of the chemistry department of one of our state universities said a short time ago that he doubted the advisability of teaching chemistry in a high school at all. This means to me simply that the possibilities of the science in the introductory courses, and in some of the following courses as well, are far from being realized. Broadly speaking the trouble consists in the too common treatment of the subject as a system of knowledge and training rather than as a means of revealing to the growing individual the vital relations between himself and his surroundings. The remedy must then be a radical change in three respects; first, in the attitude of the teacher; second, in the facts selected as a basis of the work, and third, in the methods of presenting and treating these facts.

The ordinary method of approach not only to this but also to other sciences, both in the introduction to the subject as a whole and to each subsequent division is such that the pupil inevitably feels that it is a thing apart from his ordinary interests. From my earliest experiences as a student of the natural sciences I recall the feeling that the general survey of the subject almost invariably appearing as an introduction to the subject should have been reserved for the summary at the end of the

[1]Read before the Missouri Society of Teachers of Science and Mathematics at Columbia, May 6th, 1911.

course. The pupil, unfamiliar with the details upon which the author has built these generalizations, cannot relate them to his common experiences. He develops a formal attitude toward a formal subject. Instead of beginning as our chemistry texts so commonly do, with discourses upon the wonderful order of nature followed by definitions of matter, energy, physics, chemistry, and even of atoms, molecules, valence, and so on, we must begin always with the concrete and lead to the abstractions only as these become necessary in the view of the pupil. The almost stereotyped outline for the study of a substance, namely, history, occurrence in nature, preparation in the pure condition, physical properties, chemical properties and uses, should according to our long accepted but in chemistry all but completely ignored pedagogical principle, from the known to the unknown, be almost exactly reversed. Begin with familiar uses, next characteristics leading to these uses, then other less known or unfamiliar characteristics and so on back along the list of topics.

The material selected as a basis of the work in the introductory course in this science has been chosen largely, sometimes entirely from the point of view of the logical development of a system of knowledge with the result that the facts dealt with are far removed from the past and even future experiences of the pupil. The reasons for this are easily apparent. The transformations of matter associated with our daily experiences are far more complex than some that may be selected from the great stock of chemical knowledge. Many of the facts we may wish to study, such as chemical changes in food, in paint, enamel, and cement, for example, have not yet been reduced to simple chemical equations. For the sake of definiteness consequently the simpler though less familiar facts have been used in teaching the properties of matter. The conviction that we are losing far more, however, that is of vital importance to our pupils than we gain in thus substituting matter of remote interest for that of immediate interest is growing stronger with me every day. I am confident that we can and should take almost all of the material for study from the immediate surroundings of the pupil. Some object that this would lead to narrowness. If we carry the pupil in a dream world of abstractions to Rome or Berlin without *first* helping him to *know* the real world he lives in we *are* making him narrow and inviting the development of a nature prone to prejudice and conceit; one which does not know its limitations nor its actual powers.

There has been much discussion concerning the relative prominence to be given the descriptive and the theoretical phases of the science. Properly interpreted this question can scarcely be open to discussion. The great object of the high school course in chemistry is to develop in the pupil the sanest possible view of the world he lives in. This cannot be done by introducing at more or less regular intervals in the course chapters or paragraphs dealing with hypotheses or theories as topics of importance in themselves, but must be done by associating every fact with other known facts by means of some unifying principle. By developing an actual appreciation of the meaning of such principles as the conservation of mass and of energy, chemical equivalence, the principle of least action, equilibrium, and mass action we simplify our science. By the method of unrelated facts, descriptive detail, and theory there results chiefly a collection of relics in a mental museum.

These are the three factors, then, upon which I insist; first, the necessity of building always upon the known; second, dealing with facts of actual interest to the pupil and third, the placing of the stress constantly upon the unifying principle. The latter involves always, I may add, a recognition of the energy factor in chemical changes, something which, until recently, has received very little attention.

I shall attempt by some detail to show how the results desired may be obtained. What has been said thus far applies with the same force whether teaching boys or girls. With the stress that has been laid upon dealing with facts of immediate interest, as well as building constantly upon the known, however, it is easily evident that it will be necessary to high efficiency in teaching to have the boys and the girls in separate divisions. For two years now I have had such classification at the Manual Training High School in Kansas City and I have no thought of going back to mixed classes. From every point of view my experience gives the advantage to separate divisions. My original object in this separation was chiefly to meet the needs of the girls enrolled in the household economics course and of the boys in the mechanic arts course. It is scarcely necessary to add that my effort is to correlate my work as perfectly as possible with these departments and thereby not only help those departments and my own to greater efficiency but most of all to help the pupil to see the vital meaning of his school work and its relation to his daily existence.

The outline of the first half year's work for the two divisions is in essential points the same. The girls enter my classes without previous preparation in physics, however, while the boys have this preparation. This makes it possible to pass over certain topics in less time with the latter.

Instead of using the names of elements as chapter headings as is done almost exclusively in our text-books the study should center upon topics. Only in this way can closely related phenomena be brought together so as to avoid the complexity and waste of energy attendant upon the repetition of similar facts in connection with different elements, as, for example, in the power of different metals to replace other metals in solutions of their salts, the relative stability of hydroxides, etc. The work of the first half year is a natural sequence of development through these main topics. Water as a familiar, typical, universally present, and chemically simple substance is made the basis of a study which inevitably necessitates becoming familiar with the several processes of purification of substances, with physical properties, solutions, hydration, and composition. This latter topic invites a discussion of the elements. Such subjects as vapor tension, diffusion of gases, and of substances in solution, osmotic pressure, energy, units of weight, such as moles and gramions, are discussed as occasion arises. The composition of water and the consideration of the characteristics of its elements, hydrogen and oxygen, calling for an investigation of the various possible sources of this compound, lead to the study of combustion and fuels. Again follows a study of air, respiration, and ventilation and of the characteristics of oxids. This latter furnishes the basis for a thorough study of basisity and acidity and also of the hydrolysis of salts.

May I say here that what I have just given in brief outline as a first half year's work in chemistry is with proper adaptation to conditions naturally an introductory science course which would be not only intrinsically valuable to the pupil but also most desirable as a preparation for efficient work in succeeding science courses. Some schools, I find, are already using courses essentially the same as this as their first science course.

The second half year marks a distinct differentiation of the work of the two divisions. The boys are given a detailed study of the properties of metals and alloys, including corrosion and metal plating, both hot and electrolytic. The periodic law is made the basis of the classification of the metals and their chemi-

cal activities are constantly associated with their potential differences. The study of alloys is built upon a knowledge of properties of solutions. Paints, cements, glass, porcelain, fireclay and its products are studied chiefly from the point of view of the characteristics contributed by each essential ingredient.

The girls during this second half year are led through a briefer study of the metals, then of cleaning processes, including solvents, emulsifying, and bleaching agents, of paints, cements, enamels, glass, and porcelain, antiseptics and, most of all, of food principles with some methods of testing for these. In the study of cleansing agents and of foods, particularly, there are opportunities for revealing an economic value of the facts studied; economy in the use of materials is emphasized throughout the course.

It is evident that experiments by the pupils or experiments and illustrative material before the pupils, so far as this is at all possible, is a prerequisite in order to give a concrete basis for all generalizations. But we may have experiments illustrating oxidation, for example, and then make our definition of this term almost as abstract and meaningless in the minds of the pupils as if the experiments had been omitted. Why is it so commonly remarked by teachers that they began to know their subject really only after they began to teach it? Even the great Vant Hoff asserted that this was true in his experience. The attitude of teacher and pupil toward the thing taking place before them is the vitally important factor.

In studying the nature of solution, for example, the pupil may drop a crystal of potassium permanganate into some distilled water, set this aside for half an hour and then find a mixture of the two substances. He may be told that this mixture represents a true solution, that the potassium permanganate has gone into solution and diffused through the water to produce this result. Now he has his definitions. But the vital thing is for him to have *watched* the substance disintegrating and spreading through the water and to have *thought* its meaning in terms of energy as well as of the ultimate division of the substance concerned. The measurement of this diffusion tendency in terms of osmotic pressure, the conception of molecules and ions and the kinetic theory of matter will then rise as inevitable subjects for consideration. The meaning of the facts of solubility and insolubility, precipitate, emulsion, saturation, temperature effects, and the effects of the presence of one solute upon the solubility of another may be *realized* definitely even though no such

thing as a final explanation can be offered. We feel that we know the fact of chemical combination, knowing at the same time that such terms as chemical affinity or attraction are only words and explain nothing. Yet we are prone to teach our pupils terms and definitions as if these supplied the knowledge itself. Again, crystallization means little beyond a vision of geometrical forms unless we have seen crystals growing and perhaps even big ones devouring little ones as may sometimes be seen upon a thinly frosted window. The fact of the supply of energy from the sun and of the transformation and storing of some of this in the form of chemical energy by the processes taking place in the green plants, may come to mean more than simply an accepted statement, if thought of in view of ice upon the pavement melting in bright sunlight from the lower instead of the upper surface, showing the transformation of radiant into heat energy by the opaque surface below the ice. The similarity between what happens under our feet thus and the great fact of the warming of the lower strata of the earth's atmosphere will be easily grasped.

Some writers of text-books claim that they give much emphasis to the practical applications of the science when investigation shows that they base these claims almost wholly upon detailed descriptions of manufacturing and metallurgical processes. That this is not the sense in which the term "applied chemistry" appearing at the head of this paper is used is clear. Knowing that very few of our pupils will ever have any direct interest in such processes we must realize how unimportant such descriptions are. But the worst of it is that the descriptive details are made so prominent that it is difficult for a pupil to find the underlying principles even when he makes a special effort to do so.

The assertion may be made that girls who have no knowledge of organic chemistry are not prepared to take up the study of foods in a chemistry class. Instead of preparing them for this work by taking them through a study of the homologous series of hydrocarbons and of their derivatives in various classes such as alcohols, aldehydes, acids, and esters, I venture to introduce this division of our subject by telling the girls how to get pure starch out of a raw potato at home and asking them to bring some of this starch to the laboratory for further study. A section of raw potato is examined under the microscope, first without and then with the iodine stain. A section from a baked potato is similarly treated. Then follow tests of solubility in cold and in hot water, of the effect of saliva upon raw and upon boiled

starch, using Fehling's solution to determine results. And again the hydrolysis of the starch by boiling with dilute hydrochloric acid; add to this the hydrolysis by diatase and the formation of malt. After a brief comparison of the starch from various sources such as corn, rice, wheat, beans, etc., we are ready to take up the study of the chief commercial product of starch hydrolysis, namely, glucose, then in turn cellulose, cane sugar, fats, proteids, and the rest are taken up.

If these girls continue in school, taking up organic chemistry they will know its meaning far better than if they had no knowledge of its applications. If they do not continue in school, and this means nine tenths of them, they will not carry with them a vague feeling that they have added to their other education by a drill in certain facts called collectively organic chemistry, a study of which facts having contributed to their development and culture may now be forgotten, safely. Instead of this they may reasonably be expected to be able to choose their food and also prepare it more sanely and as a consequence be more healthful and more cheerful companions for themselves and others. Perhaps also see some value in chemistry even for girls.

It may be objected that much of what I urge involves physical chemistry which is too difficult for high school pupils. As already indicated, I am confident that the study of principles and less descriptive detail simplifies at the same time that it makes our science more worth while. College men may fear that we introduce topics that we cannot develop fully and that by so doing we increase the difficulty of the teaching problems for college teachers. Again I would answer that if the college course is made vitally constructive and not mere drill there will be nothing to fear. Further, of course, we recognize that our problem is to meet the needs of the pupils at the high school age. The college teacher has his specific problems to meet.

What has been said in this paper is the outgrowth of my experience in the class room and the interpretation of these experiences. I believe I have expressed nothing that I have not felt in the presence of my pupils.

The thing hoped for in the end is that a minimum of the pupil's time and strength may have been spent in mere drill upon exercises which have no other value than the exercise, and that he may have gained an understanding and an appreciation of the nature of the materials he uses every day, such that he himself and his associates may be the more comfortable and efficient

whatever occupation he may choose to follow. That if he continues in school he may make the more rapid progress not only because of his knowledge of the general laws of matter and energy but also because of a more rational attitude toward knowledge. Therefore that the course may in the highest degree possible have served the purpose of education—the removal of limitations.

WHAT THE COLLEGE DESIRES OF THE HIGH SCHOOL IN THE TEACHING OF PHYSICAL GEOGRAPHY.

By T. C. Hopkins,
Syracuse University.

The subject assigned me was what the college *requires* of the high school. In my opinion there is only one answer to this question, namely, *nothing*. The college does not and should not make any requirements of the high school. The college does require a certain amount of preliminary training of students desiring to take up and carry on the college studies. The prospective college student is expected to show that somewhere, in some way, he has had sufficient preparation to carry on the work given in the college courses. He may get this in the high school or he may get it somewhere else. Since but a small fraction of the high school students go to college the fitting of pupils for college should be a minor factor in the work of the high school.

Is the object of the work in the high school the same as that in the college or is it different? Is it the education (the drawing out or development of the intellect) of the pupil or is it something different? Are these two schools part of a great educational system or are they something radically different? What does the college attempt to do that is not attempted in a more elementary way in the high school and vice versa? If one of these schools has a mission to perform different from the other then let it by all means stick to that mission. If they are both trying to develop the intellect and character of the youth so that they will be wiser, better, and stronger citizens then why should there be any conflict between the two unless perchance it may be as to where the one leaves off and the other begins?

Now as to physiography: let us see what the college expects or desires of the entering student and whether there is anything therein out of harmony with the high school ideals, should the student want to get this preliminary training in the high school.

The college does not *require* any student to study physical geography in the high school or any other school in order to enter the college courses. (There may possibly be some exceptions to this but I do not know of any.) It asks the pupil to have had a certain number of hours or years of study along different lines of knowledge; one of these lines *may* be (not *must* be) physiography. If he chooses physiography as one of these lines of preparation then in New York State it expects him to have done a year's work of five periods a week in that subject and further that not less than one fifth of this work should be of a practical character, commonly designated laboratory work, part of which should be the study of physiographic features and agencies in field trips. No specific requirements are made in this line; both the quantity and kind of field work will depend on the location of the school, the size of the classes and particularly the training and energy of the teacher.

The laboratory indoors will likewise from necessity vary greatly in the kind of work done; the condition being that it be made as practical as possible and involve the study of *real things*. The dictation of notes by a teacher, the copying of a description of an experiment, or the copying of a diagram is not laboratory work. It means work actually done by the student involving observation of things, handling of instruments, study of rocks or minerals or maps or models, not someone else's description of them. This work should be done under the supervision of the teacher and the results recorded in a notebook. The value of the notebook is in the making of it.

Is there anything in such a course inimical to any high school ideal? If so, is there not something wrong with the ideal?

The subject of physiography as now taught in the schools is a broad one and includes several somewhat diversified lines of study. It is not possible nor is it indeed desirable that all of these divisions should be treated exhaustively nor is it necessary that they should all be mentioned even. It is more important that one or more of the branches should be taken up with some degree of thoroughness in order that the student should get the spirit and something of the methods of scientific work.

The tendency in too many schools is to make the work too superficial and mechanical, with the idea of conning all the topics and memorizing enough to answer questions in a certain catechism. It may (or it may not) be necessary for the pupil to know something of the movements of the earth and the results

produced; of the relation of the earth to the other heavenly bodies; something of the work of the atmosphere and the water on and under the earth; the land forms; the rocks and minerals composing the earth; the kinds of animals and plants and their distribution, but if in getting this varied knowledge he fails to realize that he is actually studying or can study the book of nature, that he actually sees the omnipotent forces and agencies at work and the effects produced by them in the making of the world in which he lives and forms a part: if he fails in this he fails in the most important part of the work, and he should omit some of the topics and spend more time in the contemplation of others.

From the standpoint of the college, or from any other rational standpoint, it were better for the pupils to have a good live knowledge of one or two of the topics than a superficial word knowledge of all of them. By good knowledge I mean that he gets into the heart of the subject and sees its relation to him and his daily life and a desire to further pursue the subject. It is only the superficial pupil that "knows it all." Many of the poorest students in the college classes in physiography are those who have made a high grade in the subject in high school. He has a superficial knowledge of the subject that causes him to hold his head so high that he cannot see the earth on which he walks. He gets a memory knowledge of the nomenclature with the idea that he has the subject-matter. He can give a definition of latitude and longitude but cannot tell the difference between them on the map. To him they are "imaginary lines" without use or significance. He can define a contour map but cannot use one. Spending too much time conning text-book definitions is one reason for such a condition and a probable remedy is more laboratory and field work. Another remedy is to have trained teachers; too frequently persons are required to teach physiography who know little or nothing about it and from necessity slavishly follow the text-book and miss the inspiration of the subject.

VERTICAL WRITING SCORES IN MILWAUKEE.

By a vote of six to four the Milwaukee school board refused to change from the vertical to the slant system of writing in the public schools. The change had been recommended by a majority of a committee appointed to investigate the subject.

THE YOSEMITE VALLEY.

By Harold W. Fairbanks,
University of California, Berkeley.

To the teacher of geography California offers many attractions. Its diversified surface and different climates illustrate with remarkable distinctness the dependence of living things upon their environment; while its striking scenery arouses our interest in the operation of these great natural forces which are shaping the earth's surface.

The Yosemite Valley is perhaps the most widely known of the scenic features of California. From our earliest knowledge of this valley, when it was reached only by the rudest Indian trails, down to the present when luxurious cars land one at its very door, the Yosemite has called forth the deepest admiration, and wonder of every beholder.

One of the first questions which thoughtful people ask is: How was this wonderful valley made? Many theories have been advanced. The first was that during some convulsion of the mountains the area forming the valley dropped into the earth leaving the precipitous walls which now inclose it. Then came the view that long ago a glacier had cut this mighty chasm out of the solid rocks, as loaded with boulders and gravel it slowly moved down the mountain slope.

We now generally believe that the great canyons on the western slope of the Sierra Nevadas, like similar ones in other parts of the world are due mainly to the erosive action of detritus-laden waters. There can be no doubt that the canyons of the Kern and Kings Rivers, Hetch-Hetchy Valley and Yosemite Valley had the same origin.

All the deep canyons of the Sierra Nevada Mountains are more or less precipitous and picturesque, but the Yosemite excels the others in the height and steepness of its walls, as well as in its lofty and beautiful waterfalls.

The Sierra Nevadas consist largely of granite and a study of the development of the present topography has shown that in the process of weathering and erosion the forms which this rock assumes depends upon the presence or absence of joint planes. Where joint planes are absent and the rock is *massive* rounded dome-like knobs and peaks arise through concentric weathering and the peeling off of successive layers.

Where joint planes are present weathering results in angular

and sharp, jagged peaks. Usually several systems of joint planes exist together, and if the chief one is nearly or quite vertical the region is characterized by steep-walled canyons, and precipitous origins.

The Yosemite region is distinguished by local areas of dome structure in which joint planes are absent, and others in which vertical are remarkably well developed, so that as the canyon of the Merced River, of which the Yosemite Valley forms a local expansion, gradually grew to its present proportions, steep or vertical walls, and domes in the surrounding peaks came to be the distinguishing features.

Now let us look into the history of the Yosemite. From Glacier Point, or from Eagle Point, we have a good panoramic view of the whole region, including the Merced River and the mountains. It is not difficult to picture in our minds this deep valley with its tributary canyons filled again with rock to the top of the inclosing walls, and the Merced River flowing through a broad valley 3,000 feet above its present level. El Capitan rising nearly 4,000 feet from the present valley floor, and Le Conte dome, 5,000 feet, were then low mountains on the borders of the ancient valley.

Many suggestions of the ancient surface of which we have been speaking are to be made out in the fairly even and gently sloping sky-line of the Sierra Nevada Mountains.

Finally, there came a time of earthquake movements and volcanic activity and the region of the Sierras began to be lifted and tilted toward the West. The slope of the old streams, which had reached a graded condition, was increased, and they immediately went to work to deepen them. Thus were begun the deep canyons of the present day.

At a not very remote time, when these canyons had reached nearly their present proportions, the climate became colder and glacial ice began to accumulate in the shadows of the higher peaks. It crept down the slopes and into the canyons and, finally, reached as low as the Yosemite Valley. How long this glacial period lasted, how complex it was, and whether its period corresponded to that of the great ice sheets of the Northern and Eastern States, we do not definitely know.

The first effect of the glaciers was to sweep off and carry down all the loose and disintegrated rock material which lay in their paths. Then they began to tear out blocks of solid rock loosened by joint planes, grind and polish the surface over which they

passed, and widen the canyons through the disintegration of the rock along their margins induced by alternate freezing and thawing.

The glaciers finally melted away leaving the surface of the mountains much changed in detail but very much the same in their larger features. The rocks were bare and innumerable lakes dotted the smoothly polished basins or lay behind dams formed by terminal morains.

The remains of polished rock surfaces on the walls of the Yosemite show it to have been filled to a depth of about 1,000 feet by the glacier which once occupied it. Marginal sapping probably widened portions of the valley and left the walls more precipitous than they were before. Morainal material at the lower end formed a dam and a lake occupied the valley until it was silted full and the beautiful floor of forest and meadows was formed.

The waterfalls were more lofty and beautiful than they were before. Yosemite Creek was diverted from a portion of its old channel and forced over a lofty cliff where it now tumbles 1,100 feet in a sheer plunge. The Nevada Fall was practically brought into existence, for previous to the glacial period it flowed down from the little Yosemite Valley by a cascade. A small moraine turned the river over a cliff and now the trail ascends up the former stream bed.

The domes about the valley are not due to glacial action but rather to exfoliation as already mentioned while the steep or vertical walls are due to joint planes whose action is particularly well illustrated at "the fissure" near the south dome.

Much rock debris has accumulated at the base of all but the more massive of the cliffs since the glacial period and this is augmented every year. The walls are slowly, but surely, crumbling.

Thus we see that a combination of peculiar conditions, both of rock structure and of erosion history, have aided in giving us the wonderful Yosemite Valley.

The New School Code of Pennsylvania. The July number of The Pennsylvania School Journal contains the full text of the New School Code, which occupies nearly sixty double-column pages. Many persons who are interested in general education want this new school law, especially directors, teachers, and patrons of the schools. It will be mailed to anyone at twenty-five cents per copy. Address The School Journal, Lancaster, Pa.

AN EXPERIMENT IN THE MOUND CITY (MO.) PUBLIC SCHOOLS IN ARITHMETIC TEACHING.

By Byron Cosby,
State Normal School, Kirksville, Mo.

"From the standpoint of the child, the great waste in school comes from his inability to utilize, within the school, the experiences he gets outside, and to apply in daily life what he learns in school."—*Dewey.*

Mathematics is a difficult subject for pupil and teacher; requiring intense application and studied thought. It is hard to organize the everyday experiences into the definite statements for which mathematical thought calls. Lack of observation and previous experience prevent the learner from grasping all the elements of the question; causing him to base his argument upon incomplete premises. The problems in text-books may be well selected and well stated in general, yet abstruse and difficult to the individual. In the solution of a problem it is necessary to understand definitely what is given and what is required. The newer arithmetics have made advancement in the selection of problem material but offer only a step in the right direction. Even though the class of pupils, the environment, the text, mode of recitation, and the preparation of the teacher are strong factors, it cannot be overemphasized that it is very essential that the pupil be brought into an experimental relation to the problem material. Then instead of the recitation being a place for the teacher to find out whether or not an assigned task has been finished, and for the pupils to refer to answer books for results, it becomes the workshop where the pupil by essential and pertinent questions is logically and psychologically led to interpret the new problem in terms of his known ideas—that is, to translate the arithmetical question into his experiences.

The class exercise should be stressed. This calls for a strong personality in the teacher, as well as thorough knowledge of the subject. The knowledge and training of the teacher outside of books is a factor not to be eliminated—the teacher being the source of the pupil's knowledge, at least in directing where found. The teacher who has to depend upon "what the book says," cannot be in sympathy with individual growth, and is therefore inefficient. If teachers spent more time in home study upon actual life from the arithmetical side, and the methods of coordinating this material with arithmetical principles, along with a

psychological study of the child, the child could spend less time upon problems that are foreign to his experiences, and concentrate his energies upon known experiences with greater profit to himself. All statements and answers in arithmetic should be given in clear-cut sentences. This is possible only when the child has previous knowledge of the subject-matter.

Believing that it is necessary that the pupil get his problem material from his own experiences and that the teacher develop with the pupils the problem material we made the following experiment in the Mound City (Mo.) public schools.

Our equipment was the same as may be found in, or easily obtained in most schools. The building at which the experiment was made consisted of eight grades; from primary to eighth grade inclusive, with a separate teacher for each grade. The library consisted of a few special books for the teachers' use, and several sets of arithmetics; a meager amount of apparatus of the elementary sort, and permission from the merchants, bankers, manufacturers, and other business men to visit their plants at our pleasure.

In order to understand the nature of our problem material it may not be misleading to give examples of material that we did not use, as the following which was found in one of the present-day texts:

In Book I.

1. I have a flower bed containing 64 square feet. How long is it? (page 163)
2. How long in feet is a square yard? (page 154)
3. If each acre produces 28 bushels of wheat, what does a farmer get from 48 acres? (page 100)
4. Three boys bought a melon for fifteen cents. What shall each boy pay? (page 34)

In Book II.

1. Do you know what .528 feet means? (page 157)
2. I bought four loads of coal. The weights were as follows: 4.08 tons, 3.92 tons, 3.6 tons, 5.01 tons. How much coal did I buy? (page 93)
3. Find the cost of 5/6 dozen oranges at twenty-five cents. (page 66)

Are these problems real or artificial? Do they mean anything to you?

In Book III.

Two four inch spheres are dropped into a pail even full of water and holding 864 cubic inches. How many cubic inches are displaced? (page 230)

What does this problem mean to a boy who has not experienced any of the problems in specific gravity? Experiment will not verify the problem. Try experiment with lead balls, and then with cork or wood. These examples might be multiplied, and though these particular problems may be corrected in later editions, the books are still full of problems that are false in problem material, poorly stated or foreign to the learner's experience.

Other series of books present like weaknesses. The books furnish answers to the problems thus presenting a phase of life not actually found. Practically all of the books teach subtraction in one way and the business man insists upon changing money in a different way.

In order to get interest, effort, beauty, and practicality—the real reasons for studying arithmetic—the material learned at school should add to our resources either as usable and useful facts, or in power gained to observe the relation, and again the ability to associate facts that are pleasant to study, develop our æsthetic nature, or give us a greater advantage in control of conditions that assert themselves in everyday life. The recitation can in a large manner decide the after use of the subject. If the criticism that arithmetic is little used after it is learned at school is just, it may be removed by adequate preparation of the teacher, by change of method, and subject content. The recitation must coördinate with outside experiences, and teachers should know the problems of the farm, of the flouring mill, grist mill, canning factory, of the blacksmith, carpenter, of printing, banking, merchandising, of the elevator, of the railroad, the ice plant, the shoe factory, the electric light plant, the scoring of corn, the testing of gasoline, and similar problems in order to get the greatest development of the pupils.

The elementary grades were led to make simple measurements and observations, to state as definitely as possible, and to draw their own conclusions, from the following data collected by them under the immediate supervision of teacher or principal. The number of trees in the school yard, the number of bricks in the length and breadth of the walk, number of houses in a block, number of steps between various points in the room and yard, counting scores in games, lists of number of articles in stores, and other counting or combining problems. As the grades advanced the material was worked over in a different manner. The percentage of the number of boys or girls of all the pupils in school, number of trees that are oak or elm, what fraction of all the stores are dry-goods or drug stores, use of the number system of the streets for percentage, decimals and graph work, also using the range and township lines for location work leading to geography work in longitude and latitude, furnished problem material that is worth while. From township and range the "section" with its six hundred and forty acres and subdivisions gave the most interesting and practical problems especially as at different times the

"section" was walked over by pupils and teacher. The amount of the exports of corn and garden products from the city, the import of food and other commodities with problems of freight and express charges, the production of berry, fruit or cereal crop, the rate of work in canning factory, the capacity of the flouring mill for week or month when the daily capacity is known, the initial cost of the plant, the cost of operation, value received for manufactured articles, furnished material that is new and real when gathered by the pupils with the help of the teacher.

The advanced grades found more in proportion in the problems of machines. The lever was easily understood by the average boy from his experience with the "evener," the balance arm on scales, and drawbar, and teeter board, and other elementary machines. The lever has a real interest to a live boy if he can use the idea in his work or play or again in proportion make use of the simple exercise of finding the height of objects or in measuring inaccessible distances by using similar triangles. Solving the similar triangle or lever problem by drawing to scale will mean more than the rule that "the product of the means divided by the given extreme equals the required extreme."

Instead of taking up the problems in excavations, lumber measure, wall paper and kindred problems as found in text-books the pupil had a better idea after studying the plan, or "blue print," of a building that was being erected near the school, and from the actual problems the pupils computed the number of cubic yards (loads) of soil rock that had to be removed for the basement, the amount of stone, brick, and concrete required for the foundation, the amount of lumber, glass, shingles, sand and cement for plaster, nails, and other material that was used. These problems were not all worked out at once, but as the building was being built, and after frequent visits and much actual measuring by the pupils. These problems were of a decided worth, because the pupil had the opportunity to utilize and expand facts that he had assimilated and furnished himself. This kind of problem eliminates unreasonable data that tends to warp the judgment and has a tendency to add to the pupil's knowledge of practical things. Also problems upon the amount of ammonium chloride used in producing a ton of ice, the amount of coal needed to light the city for a month, the amount of precipitation in the district, the flow of the river, the value of the advertising in an issue of the local paper, a study of bank paper, not only enabled the pupil to learn to "figure" but helped him to see "why." Many other lines of thought as found in our city were carried out.

As to results his experiences in gathering problem material enabled the pupil to adjust his new material into its proper relation to the old, to recognize in later problems the arithmetical principle underlying the problem, and gave an incentive for attacking the problem. He could "see" what was given and what he was to find.

The problem being interpreted the solution was easy. This was not "story telling," play, or laboratory method, but life. Each child has a right to individual selection. Each uses his eyes, ears, and hands. His measuring and observing gave him clearer concepts, enabling him to distinguish early length, area, and volume, together with many other statements. The eighth grade boy or girl who spent one half day in a bank or with a corporation under his teacher and an intelligent clerk knew far more about stocks, bonds, and promissory notes and checks than he could have known from all of his work in the class room. This working knowledge of a few practical applications developed the power to apply, and convinced the pupil how indispensable arithmetical thinking is to everyday life. A few application problems that were real "thoroughly mastered in form and spirit" were worth many times the number simply memorized as facts.

In the Mound City (Mo.) public schools we tried to carry out the plan outlined above. Frequent excursions in and out of school hours were taken. The excursion to the grocery store was rich in problems for the third and fourth grades. The bank visit, with a study of notes, drafts and checks, rate of exchange, dividends and other banking terms with an explanation of savings, state, private and national banks had a tendency to make the pupil appreciative not only of school but of business in general.

A resume: The real problems are:

1. To get the teacher to understand that arithmetic teaching need not be composed of simply text-book material.
2. To select problems that are valuable as types. This develops mathematical principles that are usable though abstract.
3. How to teach the pupil to see arithmetic in life, adaptation of arithmetical principles to his observations. It leads to accuracy in conception, expression, manipulation and economy.
4. The problem of incentives is solved; the reason "why" is understood.
5. To determine by use in the school room the adaptability for elementary work. The problem gathering idea develops the initiative and furnishes individual strength.
6. To educate the public that school work can be accomplished outside of the school room as well as in the class-room.
7. To economize in the use of time. Pupils are more familiar with the details of the problems and hence are more accurate.
8. To enable the pupil to grow upon the material that he understands, and to utilize within the school, the experiences he gets outside, and to apply in daily life what he learns in school.

The above plan was worth while; it increased the per cent of enrollment, per cent of attendance and punctuality and made a

closer bond of sympathy and help between the teacher on one hand and the pupil and patron on the other hand. At the close of the year the pupils had gained more individual power, were able to use their knowledge, to use in vocation the power thus gained, and to feel that their school work had at least utility value for them. The teachers worked hard and were contented, the patrons were pleased; and to some extent there was carried out the meaning of education—to be a help to usefulness and happiness.

NEW PHYSICAL AND CHEMICAL TABLES.

The preparation of a new edition of the standard work now known as Landolt & Börnstein's "Physikalisch-chemische Tabellen" has been undertaken by Dr. Börnstein of Berlin and Dr. Roth of Greifswald. These two writers have set an admirable example in addressing a circular to men of science and scientific institutions throughout the world inviting suggestions as to additions, omissions, or other changes likely to increase the value of the work. Such suggestions should be sent either to Geh. Reg.-Rat Prof. Dr. R. Börnstein, Landhausstrasse 10, Wilmersdorf bei Berlin, or to Prof. Dr. W. A. Roth, Karlstrasse 8, Greifswald.

GLACIAL NATIONAL PARK.

Map Now Being Engraved by United States Geological Survey.

The United States Geological Survey has in process of engraving a fine topographic map of the new Glacier National Park. This map will be used in the administration of the park by the Interior Department and will also be available for distribution to the public.

This splendid people's playground, the youngest of our national parks, covers nearly a million acres in northwestern Montana just south of the Canadian line and includes the Lewis and Livingston mountain ranges, which constitute the northern Continental Divide. Throughout the area hundreds of majestic peaks rise 8,000, 9,000, or 10,000 feet above sea level, alternating with sheer-walled canyons 1,000, 2,000, and even 3,000 feet in depth, at the bottom of which dash glacial torrents. More than sixty glaciers may be found in the park, some of them several miles in area. The map shows also many lakes, large and small, nestling in the old glacier-scoured basins. The glaciers of the park are but small remnants of the mighty continental glacier which, during the Ice Age, mantled the northern portion of the American continent, yet some of them are sufficiently stupendous to challenge the daring and ability of the hardiest alpine climbers and explorers. The park is described by the federal topographers as a place of wondrous beauty, perhaps one of the most beautiful and magnificent mountain regions in the world. As long as a dozen years ago John Muir described this portion of Montana as one of the most favored spots of the continent, where men might almost find the springs of renewed life. At least, he said that a season's sojourn in this region should add ten years to the traveler's earthly sojourn.

GEOMETRY—POSITIVE VS. NEGATIVE.[1]

By A. Kennedy, M.A.,
Inspector of Schools, Weyburn, Sask.

The teaching of mathematics, particularly of geometry, has not given satisfactory results, has not given the pupils power and confidence nor has it produced teachers emancipated from the methods which have perpetuated this weakness.

Canadian teachers admit that they are not satisfied; the general type of geometry paper and the marks assigned respectively for proposition and deduction—usually ten and five—reveal this. A prominent member of the American Federation of Teachers of the Mathematical and the Natural Sciences writes: "There is very great danger of losing geometry as a required subject from the high school course." The Mathematical Association of Great Britain was organized in 1871 because of the recognized need for changes, particularly in geometry. The report of the Committee of the Mathematical Association, as well as the reports of the University Committees, recommended "a practical course in experimental geometry."

The unsatisfactory results, it was assumed, were due to the lack of inductive reasoning and to the inaccuracy of illustration. The author of one of the recent texts has stated: "The present little book is an attempt to make the processes of elementary geometry both inductive and deductive. . . . I have sought to show how a practical course in measurement, use of simple instruments and accurate construction may afford a training of service in anticipating the truths afterwards reached by deductive geometry. . . . It too often happens that in the class room triangles are alleged to be equal which are ridiculously unlike and lines are proved to be equal which the eye tells us differ in length by several inches." A second author writes: . . . "unless the teachers of geometry are willing to accept this modification in presenting the subject—the application of the theorems to things which personally interest them . . . " and still a third: "The aim of the authors has been to make geometry an attractive subject." But the practical course with its greater accuracy of illustration, its interesting and attractive features has not secured more satisfactory results. The teaching of geometry with "a practical course in experimental geometry" has failed not because of the

[1]An abstract from an address before the Mathematical and Physical Section of the Ontario Educational Association, 1910.

practical course nor because of the interest and attractiveness but because of the spirit of Euclidean treatment.

Euclid's treatment of geometry focuses the attention on the truth which he wishes one to reach regardless of the fact that often the argument may lead to other equally important truths. Euclid asks us to prove some one truth instead of asking us to prove all we can. Further, he dictates the course to be followed regardless of the course which another mind might take toward the same end. In Proposition 5, Book I, it is stated that "The angles at the base of an isosceles triangle are equal" or the pupil is asked to "prove that the angles at the base of an isosceles triangle are equal." Even if stated: "If a triangle is isosceles prove that the angles at the base are equal," the attention is focused on the equality of the pair of internal basal angles whereas the equality of the other pairs of basal angles is also involved. The full, free consideration of an isosceles triangle would yield other truths.

Again, the course of argument is arbitrary; I have no doubt that Euclid himself investigated freely but his argument gives no hint of the various other lines of thought he may have followed nor does it allow the pupil the same freedom nor encourage investigation. "In BD take any point F, and from AE the greater cut off AG equal to AF the less. Join FC and GB, ... Because the whole AF is equal to the whole AG, of which the parts AB, AC are equal, the remainder BF is equal to the remainder CG." The spirit of this argument aptly expressed by "the result will justify the course and the truth selected" develops an arbitrary and dogmatic type of mind.

Proposition 47, Book I: "In any right-angled triangle the square on the . . . . " or "If one angle of a triangle is a right angle show that the square on the . . . ;" Euclid actually passed over a truth of infinitely greater value than the end aimed at and reached; the real truth is "therefore the parallelogram BL is equal to the square GB." By continuing to "therefore the square described on the side BC is equal to the squares described on the sides, BA, AC," he missed the opportunity of opening up a whole field of truth.

"Through A draw AL parallel to BD or CE, and join AD, FC. Because the angle BAC is a right angle, and the angle BAG is also a right angle, therefore CA is in the same straight line with AG . . . ." The difficulty experienced with the argument of this proposition is surely convincing that a choice of course

would be more effective. In at least one instance many of the candidates for a first-class certificate were unable to do more with Proposition 47 than to put the illustration on the paper.

The negative spirit of Euclidean method may be further seen in the deductions. Among the exercises usually following Proposition 4, Book I, we find: "If two straight lines, AB and CD, bisect each other at right angles in O, any point in either of them, AB, is equidistant from the ends, C and D, of the other," or "Two straight lines AB and CD bisect one another at E. Prove that the triangles AEC, BED are equal in all respects." The attention is focused on one truth; I shall show later the wealth of truth which a full, free consideration of the "two straight lines bisecting one another at right angles" will give.

Euclid's treatment of the indirect argument, as in Proposition 6, Book I, and his method of solving problems, as in Proposition 2, Book II, are seldom grasped and made to increase the power of the pupil. These and other propositions are in many cases memorized for examinations.

Only a method the spirit of which is distinctly open-minded, positive, and exhaustive, will satisfy the demand and develop in the pupil power and confidence. Such a method has been used and has shown itself power-giving. Evidence in support of this statement is difficult to present save by quoting from the notes of a pupil of the Junior Form, Part I.

"Two { positions determine a { direction / straight line and / points } also a distance, { the distance between the two points / the length of the segment of the line.

Between these two points there is a point

{ equally distant from the original points / equidistant from the two points / midway between them;

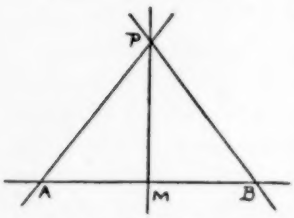
this point { bisects the segment determined by the two points / is a bisector of the segment / is a mid-point of the segment.

Through the mid-point of the line-segment may be a line

{ determining with the original line { a right angle / and / a right angle / perpendicular to the original line.

The straight line through the mid-point of a line-segment and perpendicular to the line, of which the segment is a part, is known as the RIGHT BISECTOR of the segment.

Consider a point on the right bisector of a line-segment. The end-points, A and B, of a line-segment, the mid-point, M, of the segment, and any point, P, on the right bisector of the segment determine three triangles, ABP, AMP, BMP.



Comparing two of these, AMP and BMP, we know that the segments of two sides and the angle which they determine are respectively

equal, $\begin{cases} AM = BM \\ MP = MP \\ \text{the angle } AMP = \text{the angle } BMP, \end{cases}$

so that the two triangles must be congruent, including

$\begin{cases} \text{the equality of the segments of the third sides} \\ \text{and} \\ \text{the equality of the corresponding basal angles.} \end{cases}$

$\begin{cases} AP = BP \\ \text{the angle } MAP = \text{the angle } MBP \\ \text{the angle } APM = \text{the angle } BPM. \end{cases}$

I. $AP = BP$.

The segments determined by two points and the moving point on the right bisector of the segment determined by the two points are equal.

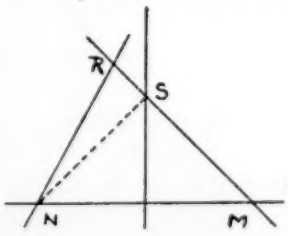
The distances of two points from any point on the right bisector of the line-segment determined by the two points are equal.

Any point on the right bisector of a line-segment is equidistant from the end-points of the segment.

Two points are equidistant from any point on the right bisector of the segment which they determine.

Two points and any point on the right bisector of the segment which they determine, determine a triangle with the segments of two sides equal.

Consider a point, R, equidistant from two points, M and N. Is it possible that this point, R, may not be on the right bisector of the segment determined by the two points, M and N? If so, the line determined by R and M would intersect the right bisector of the segment MN in a point, S, and the point S would be



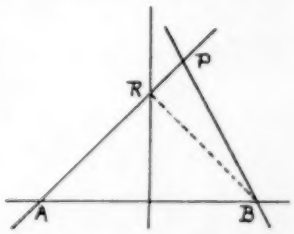
equidistant from the two original points, or SM would be equal to SN. But RM is equal to RN.

Then RM — SM would be equal to RS, RN — SN or RS + SN would be equal to RN.

But the distance along a crooked line, from R to N, is greater than the distance along the straight line so that the preceding statement cannot be true; hence the point equidistant from the two original points must be *on* the right bisector of the segment determined by these two points.

Or, consider a point equidistant from two points.

Suppose this point, P, is not on the right bisector of the segment determined by the two points, A and B; then the line PA would intersect the right bisector of the segment AB in a point, R, and RA would be equal to RB.



But $\begin{cases} \text{PR + RA is equal to PA.} \\ \text{PA is equal to PB.} \end{cases}$

Then PR + RB would be equal to PB; but this cannot be true. Therefore the point, P, equidistant from two points must be *on* the right bisector of the segment determined by the two points, A and B.

A point equidistant from two points must be *on* the right bisector of the segment which those points determine.

A triangle with the segments of two sides equal must have its vertex *on* the right bisector of the segment of the base.

A triangle with the segments of two sides equal is known as an isosceles triangle.

A triangle with the segments of three sides equal is known as an equilateral triangle.

An equilateral triangle then has each vertex *on* the right bisector of the segment of the corresponding base.

The hypothesis—"Any point on the right bisector of a line-segment," gave us by a direct argument a conclusion of three parts, each important. The first part we have expressed—"Any point on the right bisector of a line-segment must be equidistant from the points which determine the segment."

We then asked ourselves regarding "any point equidistant from two points" and answered the question by means of an indirect argument obtaining the theorem, "An isosceles triangle must have its vertex *on* the right bisector of the segment of the base."

This theorem is the *converse* of the preceding theorem.

Again from the hypothesis, "A point on the right bisector of a line-segment," we obtained as a second part of the conclusion, "The angle MAP is equal to the angle MBP."

The angle determined by a straight line and the line through one of the end-points determining a segment of the original line and a point on the right bisector of the line-segment is equal to the angle determined by the original line and the line through the other end-point on the right bisector of the segment.

The angles determined by a straight line and the lines through the end-points of a segment of the original line and any point on the right bisector of the segment are equal.

The straight lines determined by any point on the right bisector of a line-segment and the end-points of the segment determine with the line of which the segment is a part, angles which are equal.

A point on the right bisector of a line-segment determines with the end-points of the segment two lines which determine with the original line angles which are equal.

A triangle with the segments of two sides equal has its basal angles equal.

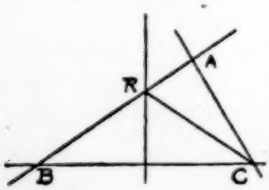
An isosceles triangle must have its basal angles equal.

This theorem refers not only to the equality of the internal basal angles but also to the equality of the external basal angles.

What must be true of a triangle which has two of its angles equal?

Or, consider a triangle, ABC, with two of its angles equal.

Can { this triangle not be isosceles?
this triangle not have the segments of two sides equal?
the vertex not be equidistant from the basal vertices?
the vertex not be on the right bisector of the segment of the base?



If so, either side of the triangle would intersect the right bisector of the segment of the base in a point, R, other than the vertex. This point would determine with the basal vertices an isosceles triangle and the basal angles of this triangle would be equal; the angle RBC would be equal to the angle RCB.

But the angle ABC is equal to the angle ACB. It is impossible that an angle may be equal to two different angles. Then the vertex of the original triangle must be on the right bisector of the segment of the base.

Or, the vertex must be equidistant from the basal vertices.

Or, the triangle must be isosceles.

A triangle with two of its angles equal must be isosceles.

As a special case—A triangle with its three angles equal must be equilateral.

From the hypothesis, "A point on the right bisector of a line-segment," we obtained as a third part of the conclusion, "The angle APM is equal to the angle BPM."

The angle determined by the right bisector of a line-segment and the line through any point on the right bisector and one of the end-points of the segment is equal to the angle determined by the right bisector and the line through the point on the right bisector and the other end-points of the segment.

The angles determined by the right bisector of a line-segment and the lines through any point on the right bisector and the end-points of the segment are equal.

The right bisector of a line-segment determines with the lines through any point on the right bisector and the end-points of the segment angles which are equal.

The right bisector of the segment of the base of an isosceles triangle bisects the vertical angle.

The right bisector of the segment of the base of an isosceles triangle is { the bisector of the internal vertical angle. / the internal bisector of the vertical angle. } The external bisector of the vertical angle of an isosceles triangle is then parallel to the base.

Since the segment of the base of an isosceles triangle has *but one* right bisector, and the vertical angle has *but one* internal bisector we may be satisfied that the internal bisector of the vertical angle of an isosceles triangle must be the right bisector of the segment of the base.

As a special case, the internal bisectors of the angles of an equilateral triangle are the right bisectors of the segments of the corresponding bases.

Having defined a circle, a secant, chord, and so on, the theorem, "Any point on the right bisector of a line-segment is equidistant

from the points which determine the segment" may be otherwise expressed as follows: "The right bisector of any chord must be a center line."

As a special case—The line through the point of contact of a tangent, perpendicular to the tangent, must be a center line.

Since a segment has *but one* right bisector and a circle has *but one* center, a center line which bisects a chord must be perpendicular to the secant.

As a special case—A center line which passes through the point of contact of a tangent must be perpendicular to the tangent.

Also a center line which is perpendicular to a secant must bisect the chord.

As a special case—A center line which is perpendicular to a tangent must pass through its point of contact."

Permit me to call attention to the expression in this treatment. The pupils of the Junior Form, Part I, expressed the truths in that variety of ways which is here quoted and this power of expression is to that extent an indication of their power of thought.

These notes also give a satisfactory answer to a question frequently asked as to the value of such a method to pupils approaching geometry for the first time.

GOLD FROM COPPER ORES.

The production of gold from copper ores in 1909 was valued at $5,631,885, against an output of $4,812,993 in 1908. Material increases of gold from these ores are noted for Colorado, Nevada, California, and Utah, in order named, due to increased copper output. The copper ores are mainly sulphides, with a greater tonnage containing chalcocite than chalcopyrite; and the great disseminated deposits of Utah, Arizona, and Nevada are of constantly increasing importance. These ores are mainly concentrated before smelting. Oxidized ores of decreasing relative importance still come from the Bisbee and Tintic districts; these are commonly smelted crude and are sought for as fluxing ores. Gold in copper ores is mainly recovered in the electrolytic copper refineries and is, therefore, lost and not reported for the relatively small proportion of copper not so refined.

EFFECT OF WATER IN WATER-PROOFING CONCRETE has long been recognized, according to C. M. Chapman in a paper read before the National Association of Cement Users, that the quantity of water used in mixing concrete has a large influence upon the impermeability of the resulting mass. A concrete may be too wet or too dry to produce the most impermeable product, and one extreme is as bad as the other. The theory is generally held that, other conditions being the same, a wet mix makes a more waterproof concrete than a dry mix, as the latter produces a more porous mass, unless very tightly compacted by much hard tamping or enormous pressure. A slight difference in the percentage of water used will make a large difference in permeability.

EXPERIMENTS ON DYEING FOR HIGH SCHOOL CLASSES IN CHEMISTRY.[1]

By Gilbert H. Trafton,

Mankato Normal School, Minnesota.

I. EFFECTS OF CHEMICALS ON VARIOUS KINDS OF FIBERS.

1. Action of acids on wool and cotton.

Pour about 1 c.c. of concentrated H_2SO_4 into 25 c.c. of water in an evaporating dish. In this boil a piece of wool and a piece of cotton for about 15 minutes. Remove the pieces, squeeze out the excess of liquid without washing, and dry. After drying test the strength of the pieces.

(Cotton very much weakened, wool only slightly effected.)

2. Action of organic acids on cotton.

Pour 1 c.c. of acetic acid into 25 c.c. of water in an evaporating dish. Place in this a piece of cotton cloth and keep it heated to a point a little below boiling for about 15 minutes. Squeeze out excess of liquid and dry without washing. Test the dried cloth.

(Little effect on cotton.)

3. Action of alkalies on wool and cotton.

Boil a piece of wool and one of cotton for 5 minutes in 25 c.c. of a solution of NaOH (30 c.c. water to 1 c.c. NaOH solution—60° Tw.) Wash and dry. (Wool dissolved; cotton not affected.)

Repeat the experiment with new pieces of cloth, using Na_2CO_3 instead NaOH. Boil for 15 minutes, wash, and dry. (Wool much weakened; cotton not affected.)

Repeat using $(NH_4)_2CO_3$. Boil 15 minutes, wash, then dry. (Neither effected.)

4. Action of metallic salts (mordants) on wool and cotton.

Place in an evaporating dish 25 c.c. of chrome solution (1 to 25). In this place pieces of cotton and wool and boil for 10 minutes. Rinse in water. Place the wool, together with a piece of unmordanted wool, in 25 c.c. of alizarin (or madder) (1 g. per liter water). Boil for 3 minutes. Wash well and dry.

(Unmordanted not affected, mordanted colored.)

II. TO STUDY THE CONDITIONS AFFECTING THE DYEING OF CLOTH.

1. Effect of the bath on dyeing.

Add 10 g. Glauber's salts to a liter of water. Dissolve 4 g. castile soap in a liter of water. Take 15 c.c. of the Glauber's salts. To this add enough soap solution to get a good lather. Then add 15 c.c. of a solution of diamine sky blue (a substantive dye), made by adding 1 g. of the dye to 1 liter of water. In this put a piece of cotton cloth, one of wool, and one of silk. Stir and heat 5 minutes. Rinse cloth in cold water. Record results. Dry cloth and paste in notebook, labeling kind of cloth, and dye used.

If in doubt as to whether a fiber is dyed, wash in hot soap solution, and rinse in cold water.

(Wool and silk not effected; cotton blue; Glauber's salts gives deeper color.)

Again start with 10 c.c. of Glauber's salts; add 5 c.c. of acetic acid made by mixing 10 c.c. of strong acid with 1 liter of water. Add 15 c.c. of same dye used in previous experiment and finish experiment as there directed.

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[1]The explanations in parentheses are inserted for the benefit of the teacher and, of course, it is not intended that they shall be given the pupil.

The experiments here given have been successfully used by the writer in his classes in chemistry.

How do the results of the two experiments differ? What caused the difference?

(Cotton lightest; wool and silk [animal] deepest.)

2. Effect of the dye.

Add 10 c.c. strong acetic acid to 1 liter water. Take 10 c.c. of this and to it add 15 c.c. of solution of rhodamine dye (acid) made by adding ½ g. of dye to 1 liter of water. Put in 3 pieces of cloth (cotton, wool, and silk), stir and boil 5 minutes. Rinse in hot soap solution and then in cold water. Dry and mount in notebook.

(Silk and wool, red; cotton not effected.)

To 10 c.c. of the diluted acetic acid made as directed above add 15 c.c. of solution of violet dye (½ g. to 1 liter of water). Add 3 pieces of cloth, boil 5 minutes, stirring. Rinse in hot soap solution, then in cold water. Dry.

(Cotton not effected; wool and silk violet.)

3. Effect of temperature on dyeing.

To 10 c.c. of diluted acetic acid add 15 c.c. of solution of lanafushin dye (acid), made by adding 1 g. of dye to 1 liter of water. Add piece of wool and piece of silk. Boil 10 minutes, stir. Rinse in hot soap solution and then in cold water. (Wool dyed; silk not.)

Again take 10 c.c. of acetic acid and 15 c.c. of the dye. Heat till solution becomes lukewarm, then remove flame. Be careful not to heat too long. Put in pieces of wool and silk and allow to stand 3 minutes. Rinse in soap and water. Compare results with previous experiment.

(Silk dyed; wool not.)

4. Effect of fiber.

The effect of the fiber may be determined by examining the results of the three previous experiments.

III. TO STUDY THE ACTION OF VARIOUS KINDS OF DYES.

1. The action of mordant dyes.

A. To 15 c.c. of cold water add a small piece of soap. Add 10 c.c. of solution of alizarin. Heat to boiling. Place in this four pieces of silk, one unmordanted, one mordanted with aluminium, one with chrome, and one with iron. Remove and rinse in hot soap solution and then in cold water.

(Unmordanted not effected; aluminium red, chrome brown, iron dark.)

B. Make a soap solution and heat, add hematine solution. Remove flame. Dip in four pieces of silk of the same kind as in previous experiment. Rinse in hot soap solution and then in cold water.

(Unmordanted not colored, aluminium, chrome, and iron, 3 shades of black.)

C. Dissolve a little potassium ferrocyanide in water. Add a little HCl. Heat. Put in a piece of unmordanted silk and one of the iron mordant. Allow to remain for a minute. Rinse.

(Iron blue, unmordanted not colored.)

2. The action of pigment dyes.

Add 25 g. of lead acetate to 1 liter of water. Take 25 c.c. of this solution in an evaporating dish. In this cold solution place pieces of cotton, wool, and silk. Allow to remain for 10 minutes, stirring occasionally. Add 10 grams of potassium bi-chromate to 1 liter of water. Take 25 c.c. of this solution. In this place the pieces of cloth which have been immersed in the lead acetate solution, first removing the excess of liquid from the cloth. Allow to stand for 10 minutes. Wash in cold water.

(Dyed yellow.)

3. The action of basic dyes.

Take 25 c.c. of a solution of magenta. Place in this pieces of cotton, wool, and silk. Boil for 15 minutes. Wash well and dry.

(Silk and wool colored, cotton only slightly.)

Take another piece of cotton and heat for 15 minutes in a solution of tannic acid (1 part acid to 30 water). Squeeze out the liquid and then heat for 15 minutes in magenta.

(Cotton is now colored.)

4. Action of substantive dyes.

Take 25 c.c. of a solution of benzopurpurin 4B (1 g. dye to 1 liter of water). Add pieces of cotton, wool, and silk. Boil for 15 minutes. Wash and dry.

(All dye directly.)

IV. TO DETERMINE THE KINDS OF FIBER IN A CLOTH.

1. To find the proportion of cotton, silk, and wool in a cloth.

Weigh a piece of cloth. Heat in concentrated HCl for about 2 minutes at a temperature of 125 degrees F. This dissolves the silk. Wash the cloth, dry, and weigh. The loss in weight represents the silk.

Boil the remainder of the cloth for 10 minutes in a 5 per cent solution of KOH. This dissolves the wool. Wash the remaining cloth in water and then in very weak acetic acid. Dry and weigh. The loss in weight compared with the second weight represents the wool. The final weight represents the cotton.

If it is not known at the start what kinds of fiber are in the cloth, the same tests may be applied.

2. To find the proportion of wool and cotton.

Perform above experiment, omitting the use of HCl.

3. To find the proportion of wool and silk.

Perform as above, finishing with the use of KOH.

4. To find the proportion of cotton and silk.

Perform as above, omitting the KOH.

5. To distinguish between linen and cotton.

Heat a piece of cotton and one of linen for 2 minutes in concentrated H_2SO_4. Wash with water, gently rub with the fingers and steep in dilute ammonia; then squeeze and dry.

What differences do you note?

(The cotton fibers will be converted into a jelly-like mass by the action of the acid and are more or less completely removed by the rubbing and washing. The linen remains but little altered.) By weighing, the proportions may be found.

(b) Steep a piece of cotton and one of linen for 5 minutes in 10 c.c. of olive oil. Then press between filter paper, to remove the excess of oil. Note difference in appearance.

(The linen fibers will become gelatinous in appearance and translucent, whereas the cotton is unaltered. Placed on a dark background and note difference in color. (Linen fibers appear dark and cotton light.)

SCHOOL EXPENDITURES IN THE UNITED STATES.

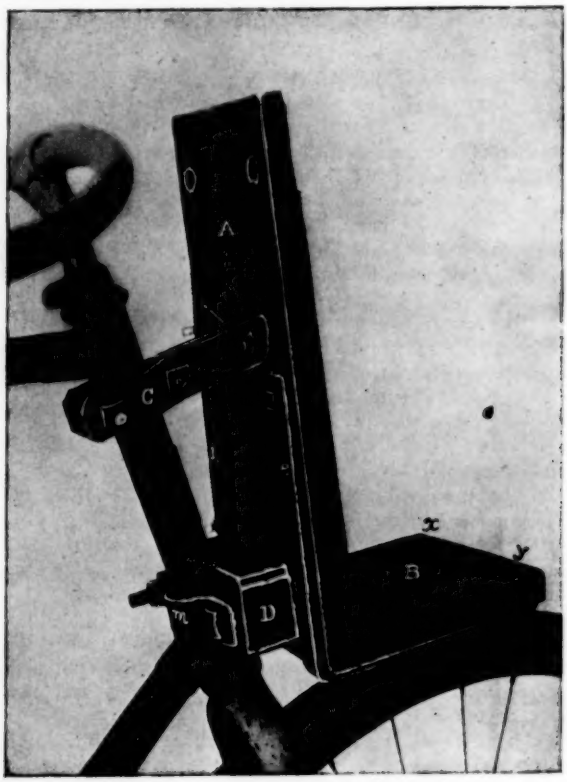
The expenditures for school purposes per capita of population increased as follows from 1870 to 1908:

United States as a Whole	$1.75 to $4.27
North Atlantic Division	2.38 to 5.54
South Atlantic Division	.63 to 1.95
South Central Division	.73 to 1.80
North Central Division	2.14 to 5.03
Western Division	2.15 to 7.49

CARRYING A CAMERA ON A BICYCLE.

By Rollin Blackman.

Being in need of a means to carry a cumbersome photographic outfit on a bicycle, I made for the purpose a successful device which clamps on the head of the frame. I have no trouble carrying my 5x7 view outfit (which weighs nineteen pounds) at a rapid rate. The outfit being stationary on the head of the bicycle does not throw the rider out of balance as it would if it were fastened on the handle-bars.



The accompanying illustration will give the reader an idea of its construction without much description. However, a few facts and figures may be of service. I bought a compact dress suit case, 17½ inches long, 11½ inches in depth, and 5½ inches wide, in which to carry my view camera, plate-holders, focusing cloth, tripod-head, and sample pictures.

The upright board A in the illustration is 6 inches wide, ⅞ inch thick, and 14 inches long. The base B is 6 inches wide, 6¼ inches long, and ⅞ inch thick. This board frame is reinforced and held together by the irons *e* and *i*, which are in the form of an "L" and fastened on with ¼ inch bolts. They are ¾ inch wide and $^{3}/_{16}$ inch thick. The iron clamp C is made of iron 1¼ inches wide and $^{3}/_{16}$ inch thick. D is a wooden block 1¾ x 1¾ x 4½ inches hollowed out to fit the bicycle head. Two ⅜ inch bolts pass through it and hold the iron clamp M. The upright board A is

covered on the front side with corduroy to prevent wearing the carrying-case. Of course the size of the device may be altered to fit other outfits.

The carrying-case is strapped on by passing a long whang-leather strap ⅝ inch wide through the ⅜ inch holes *x* and *y* and then looping each strap once around the handle of the carrying case and inserting them through the holes at the top of the carrier and buckling. The sliding and folding tripod may be carried on top of the carrying case.—*Photo-Era Magazine.*

SCIENTIFIC STUDY OF EDUCATION IN BIOLOGY—BIBLIOGRAPHY.

Thorndyke, Edward L.

Testing the Results of Science Teaching. SCHOOL SCIENCE AND MATHEMATICS *11*: 315-320, April, 1911.

A brief paper by a leading psychologist who has been particularly active in the contemporary attempt to subject educational phenomena to accurate measurement. Suggestive and practical.

Weckel, Ada L.

The Present Condition of Science in the High School. SCHOOL SCIENCE AND MATHEMATICS *11*: 406-409. May, 1911.

A discussion, based upon high school statistics, which shows the present uncertainty in the organization of the sciences.

Caldwell, O. W.

Bibliography of Science Teaching—Biology. U. S. Bureau of Education Bulletin, 1911. No. 1. A valuable bibliography. Ninety-seven titles.

Caldwell, O. W.. Galloway, T. W., and Norris, H. W.

An Investigation of the Teaching of Biological Subjects in Secondary Schools. SCHOOL SCIENCE AND MATHEMATICS *9*: 581-597. June, 1909.

A valuable piece of investigation.

Lloyd, F. E., and Bigelow, M. A.

The Teaching of Biology in the Secondary School. Longmans, Green & Co., 1904. xiii+491p.

A well-known manual addressed to the teacher.

WEARING AWAY OF MOTHER EARTH.

Investigations by the United States Geological Survey of the erosion of numerous drainage basins of the United States show that the surface of the country is being removed at the average rate of about an inch in 760 years. Though this amount seems trivial when spread over the surface of the country, it becomes stupendous when considered as a total, or even in separate drainage basins. Mississippi River, for instance, carries annually to the sea 136,400,000 tons of dissolved matter and 340,500,000 tons of suspended matter, and of this total Ohio River carries 83,350,000 tons and Missouri River contributes more than twice as much. Colorado River, which has built up for itself a vast delta, brings down more suspended matter than any other river in the United States, delivering annually 387 tons for each square mile of its drainage basin, or a total of 100,740,000 tons.

The rivers of the United States carry to tidewater every year 270,000,000 tons of dissolved matter and 513,000,000 of suspended matter. This total of 783,000,000 tons represents more than 350,000,000 cubic yards of rock, or 610,000,000 cubic yards of surface soil. If this erosive action had been concentrated on the Isthmus of Panama at the time of American occupation it would have excavated the prism for an eighty-five foot level canal in about seventy-three days.

ARTICLES IN CURRENT MAGAZINES.

American Forestry for May: "State Forests in Vermont," Walter K. Wildes (with six illustrations); "Taxation of Forest Lands," Edwin A. Start; "Planting in the National Forests" (fifteen pictures); "Forest Fires in North America," Dr. E. Deckert (translated and condensed by George Wetmore Colles); "Purple Basket Willow," C. D. Mell (with four illustrations); "The Appalachian Forests." For June: "A National Capital Forest," William M. Ellicott; "A Report on the Washington Forest," F. W. Besley; "Handling the Fire Peril," E. T. Allen; "Insects Injurious to Forests" (illustrations from U. S. Bureau of Entomology); "Bamboo Pulp as the Paper Material of the Future," Harry Vincent.

American Naturalist for July: "Germ-cell Determinants and Their Significance," Professor R. W. Hegner; "Further Observations on the Pose of the Sauropodous Dinosaurs," Oliver P. Hay.

Catholic Educational Review for June: "The Diocesan Teachers' Institute," Edwin V. O'Hara; "Splitting the Difference in Education," Francis P. Donnelly; "Benedictine Education in the United States," Michael Ott; "How to Study the History of Education," William Turner; "Twentieth Century Praise of Books," James A. Hartigan.

Education for June: "Vocational Training in the Public Schools," Charles A. King; "How to Reach the Individual Student," J. E. Hickman; "The Teaching of Natural Science in Our American High Schools," Frank P. Whitney.

Educational Psychology for June: "Measurements as Applied to School Hygiene," Luther H. Gulick; "Transfer of Training in Arithmetical Operations," Daniel Starch; "Retention as Related to Repetition," William H. Pyle; "Psychology in the Normal School," M. V. O'Shea.

Journal of Geography for May: "The Great Plains in Their Relation to Human Occupation and Development," Caroline W. Hotchkiss; "Short Studies Abroad: The Seven Hills of Rome" (concluded), W. M. Davis; "The World's Great Rivers: The Nile," William Libbey; "Laboratory Work in High School Geography," E. F. Bean; "Geographical Instruction in German Elementary Schools," Anton Jahr. For June: "Geographical Influences in the Development of California," James F. Chamberlain; "Topographic Environment of San Francisco," Ruliff S. Holway; "The Yosemite Valley," Mabel B. Peirson; "The Sequoias," T. P. Lukens; "The California Oil Industry," Ralph Arnold; "The Raisin Industry in California," Edna E. Rowell; "The Geographical Determinants of Los Angeles," W. H. Snyder; "Lake Tahoe, California-Nevada," George D. Louderback.

L'Enseignement Mathématique for May: "Charles Méray," C. A. Laisant; "Les Principes de la Géométrie des Quinconces," A. Aubry; "Une Construction de l'Hyperbole comme lieu de Points et comme Enveloppe," Georges Majcen; "Régions définies par une Hyperbole," P. Poyet; "Différentielle et Dérivée," A. Schülke.

Mathematical Gazette for May: "On Tertial, Quintal, etc., Fractions," Lt.-Col. Allan Cunningham; "Elliptic Trammels and Fagnano Points," P. J. Harding; "The Teaching of Limits and Convergence to Scholarship Candidates," W. P. Milne; "Analysis and Projective Geometry," C. V. Durell.

Mining Science for May 4: "The Present Status of the Silver Industry and Markets;" "Dry Placer Operations in the Deserts of the Altar District, Sonora;" "A Brief Survey of the Geology of the California Petroleum Districts;" "Development of the Peat Industry in the United States and Canada;" "Prospecting for Dredging Ground in California." For May 11: "Methods of Analysis for the Detection of Rare Minerals;" "A Discussion of the Genesis of Ore Deposits;" "Experiments Bearing upon the Most Efficient Conditions of Producer Gas Formation;" "The Geology of the Petroleum Deposits of the San Juan Region, Utah;" "The Use of Mine Punchers of the Pneuma-electric Type;" "Breaking Down Gravel and Disposal of Waste in Hydraulic Placer Mining."

Nature-Study Review for May: "Educational Museum of St. Louis Public Schools," Amelia Meissner; "The School Museum," Grant Smith; "Place of Observation in Nature-Study," Gilbert H. Trafton; "Time Economy and Teaching Devices," C. H. Robison; "Nature-Study on the Program," John Dearness; "What Nature-Study Does for Child and Teacher," Anna B. Comstock.

Photo-Era for June: "Portraits without Retouching," Arthur Hammond; "Making Your Vacation Pay," Frederick F. Ames, Jr.; "Focal-Depths of Lenses," Gaston M. Alves; "Decorative Flower-Studies," William S. Davis; "Carrying a Camera on a Bicycle," Rollin Blackman; "The Lure

of the Camera," Belmont Odell; "Panoramic Pictures with an Ordinary Camera," I. W. Blake; "Can a Photograph Be a Work of Art?" The Boston *Globe*.

Popular Astronomy for June-July: "Methods of Silvering Mirrors," Heber D. Curtis; "An Inquiry into a Certain Application of the Theory of Probabilities," Thomas B. Dixcy; "The Riefler Clock System of the Cincinnati Observatory," Elliott Smith; "The Gyroscope as a Compass," Hyland C. Kirk; "The Computation of the Times of Rising and Setting of the Moon, Addendum," Albert S. Flint.

Popular Science for June: "The Measurement of Natural Selection," Dr. J. Arthur Harris; "The Relation of Biology to Agriculture," Professor F. R. Marshall; "Is Euclid's Geometry Merely a Theory?" Dr. Edward Moffat Weyer; "The Underlying Facts of Science," Alfred Sang; "The Vienna Institution for Experimental Biology," Professor Charles Lincoln Edwards; "The Relation of the Manual Arts to Health," Professor Lewis M. Terman; "What Masterpieces of Greek Sculpture Were Known to the Men of the Renaissance?" Dr. Edward S. Holden. For July: "Pasteur, a Study in Greatness," Professor Fernando Wood Martin; "Concealing Coloration," Abbott H. Thayer; "Expansion of the Usefulness of Natural History Museums," Professor Thomas H. Montgomery, Jr.; "The History and Varieties of Human Speech," Dr. Edward Sapir; "University Standards and Student Activities," Orris Leslie Elliott; "The Psychology of Mental Deficiency," Dr. Bird T. Baldwin.

School Review for June: "State, Church, and School in France: IV, Moral Education as an Ideal of the French Republic," David Saville Muzzey; "The Importance of a Study-Program for High School Pupils," W. C. Reavis.

School World for May: "The Constitution and Work of Industrial and Reformatory Schools," E. B. Wood; "The School-Leaving Age," J. T. Phillipson; "The Teaching of Geography," London County Report of a Conference on the Teaching of Geography in London Elementary Schools; "A System of National Education," Miss Isabel Cleghorn; "Cambridge Local Examinations, 1910: Hints to Teachers from the Examiners' Reports."

Scientific American for May 27: The Seventeen-Year Locust or Periodical Cicada," L. O. Howard; "The New York Public Library" (illustrated). For June 3: "Hitting the Target at Seven Miles Battle Practice in the U. S. Navy;" "The New Ship Canal and Locks of the St. Mary's River," James C. Mills. For June 3: "Mad Dogs and Hydrophobia," John B. Huber; "Col. George W. Goethok, Canal Builder," William A. DuPay; "Making Life Figures of the Roosevelt Trophies," Day A. Willey.

Sibley Journal of Engineering for May: "The Oberammergau Single Phase Railway," E. W. Jansen; "A New Transmission Dynamometer," D. D. Huyett; "The Engineering Research Department of Sibley College: The Slide Valve Gas Engine for Automobiles," R. C. Carpenter. For June: "The Nature of Transients in Electrical Engineering," C. P. Steinmetz; "Application of Scientific Accounting to Promote Industrial Efficiency," L. R. Pomeroy; "Control Features of Railroad Interlocking Plants," Frank Nicholson, '12.

Unterrichtsblätter für Mathematik und Naturwissenschaften, Nr. 3: "Grenzgänge eines Biologen," Professor Dr. Schwarze; "Die Integralrechnung an Gymnasien," Professor Dr. Emil Schulze; "Notiz zur stetigen Teilung einer Streke," C. Hoffmann; "Bildung kubischer Gleichungen mit rationalen Wurzeln," Direktor Dr. O. Schneider; "Ministerialerlass vom 4. November, 1910, über den naturgeschichtlichen Unterricht in den oberen Klassen höherer Lehranstalten."

Zeitschrift für den Physikalischen und Chemischen Unterricht for May: "Zur Systematik des Unterrichtsganges in der Elektrizitätslehre," H. Kleinpeter; "Einige chemische Vorlesungsversuche," C. Zenghelis; "Optische Schülerübungen," M. Salzer; "Eine Bestimmung der Fallbeschleunigung am frei fallenden Körper," Ottinger und J. Weitz; "Die durch ein Gewicht hervorgerufene Zentralbewegung," E. Schulze; "Apparat zur Erzeugung einer Epizykloide," W. Pfeifer; Kleine Mitteilungen; "Ein lehrreicher Pendelversuch," W. Volkmann; "Ein Werkzeug als Handschwungmaschine," M. Freyer; "Die Stellung der Mondsichel," M. Koppe; "Zur Kritik der Lehre vom hydrodynamischen Druck," H. Kleinpeter.

Zeitschrift für Mathematischen und Naturwissenschaftlichen Unterricht for May: "Neue Formen für den ersten sphärischen Kosinussatz und ihre Benutzung zur Ableitung aller Formeln der sphärischen Trigonometrie," Dr. E. Eckhardt; "Zur Dreiteilung des Winkels," Professor Dr. Diesing; "Figuren von konstanter Breite," Karl Lademann; "Zur Reformbewegung auf dem Gebiete des mathematischen und naturwissenschaftlichen Unterrichts," redigiert von Dr. W. Lietzmann; "Zur Geometrographie," redigiert von K. Hagge.

PERSONALS.

Colgate University has conferred the honorary degree of doctor of science upon Professor Herbert E. Slaught of the University of Chicago. This is in recognition of his splendid work in elevating the standard of mathematics teaching.

The George Washington University has conferred the honorary degree of doctor of medicine on Dr. L. O. Howard, chief of the Bureau of Entomology and permanent secretary of the American Association for the Advancement of Science, for "distinguished services to science in relation to preventive medicine."

The annual lecture before the Northwestern Chapter of Sigma Xi was delivered by Professor Herbert N. McCoy of the University of Chicago on the subject, "Radio-Activity and the Nature of Matter."

Professor Albert A. Michelson, head of the department of physics in the University of Chicago, had recently conferred upon him the honorary degree of doctor of philosophy by the University of Göttingen.

Director George E. Hale of the Solar Observatory on Mount Wilson has received the degree of doctor of science from Cambridge University.

Dr. David Starr Jordan, Cornell '72, has tendered to President Taft his resignation as international commissioner of fisheries. This position was created three years ago under the treaty of April 11, 1908, with Great Britain. Under the terms of the appointment, the work of the commissioner ceases on the completion of the series of fishery regulations of the boundary waters, and the technical investigations necessary for their completion. This work being finished, the administration of the treaty passed to the Bureau of Fisheries.

Dr. Jordan gives the principal address at the fall meeting of the Central Association of Science and Mathematics Teachers. This meeting will be held at the Lewis Institute, Chicago, during the Thanksgiving recess.

Emeritus Professor Dr. Burt G. Wilder leaves Cornell University after forty-three years of continuous service as professor of neurology, vertebrate zoölogy, and physiology, to make his future home in Brookline, Mass. Dr. Wilder says he has work enough on hand to keep him busy for at least twenty years.

Columbia University has conferred its doctorate of laws on Professor C. F. Chandler, who retires this year from the chair of chemistry after forty-seven years of active service.

Dr. C. S. Sargent, director of the Arnold Arboretum, Harvard University, has been elected an honorary member of the Société Nationale d'Acclimation de France, and an honorary member of the Royal Irish Academy.

Frank Loxley Griffin, Ph.D. (Chicago), assistant professor of mathematics at Williams College, Williamstown, Mass., has been appointed professor of mathematics at Reed College, the new institution at Portland, Ore., which is to open September 18, 1911.

Harvard University has conferred the doctorate of letters on Dr. Josiah Royce, professor of philosophy, and the degree of master of arts on Dr. William B. Coley, professor of clinical surgery in Cornell Medical College, on Professor Henry S. Graves, chief forester of the U. S. Forest Service, and on Major W. V. Judson, of the corps of engineers of the U. S. Army.

Dartmouth College has conferred its doctorate of science on Professor Edwin B. Frost, of the class '86, director of the Yerkes Observatory and formerly professor of astronomy at Dartmouth College.

Amherst College has conferred its doctorate of laws on Dr. Walter Wyman, of the class of '70, surgeon general of the U. S. Public Health and Marine Hospital Service.

The degree of doctor of engineering has been conferred by the University of Illinois upon Mr. Ralph Modjeski, bridge engineer.

Dr. R. A. Millikan, professor of physics in the University of Chicago, has been given a doctorate of science by Oberlin College.

The Jefferson Medical College has conferred the degree of Sc.D. on Dr. Victor G. Heiser, class of '96, director of health in the Philippine Islands.

Dr. Edgar F. Smith, provost of the University of Pennsylvania, has been given the doctorate of laws by Rutgers College.

The doctorate of science has been conferred by Wesleyan University on Dr. F. G. Benedict, director of the Nutrition Laboratory of the Carnegie Institution and by Tufts College on Dr. A. P. Wills, professor of mathematical physics in Columbia University.

The University of Pennsylvania has conferred an honorary doctorate of veterinary medicine on Dr. Veranus A. Moore of the State Veterinary Department of Cornell University.

Brown University has given a doctorate of science to Dr. H. J. Wheeler, director of the Experiment Station of the Rhode Island College, and the master of arts to Mr. F. E. Seagrave, astronomer, of Providence.

Professor Franklin W. Hooper, director of the Brooklyn Institute of Arts and Sciences, has received the doctorate of laws from Middlebury College.

Professor William G. Raymond, head of the department of civil engineering and dean of the College of Applied Science at the State University of Iowa, has been elected president of the Society for the Promotion of Engineering Education.

Among the honorary degrees conferred by Yale University are doctorates of laws on Dr. Josiah Royce, professor of philosophy at Harvard University, and Dr. George E. Vincent, president of the University of Minnesota; the doctorate of science on Professor W. H. Howell, professor of physiology in the Johns Hopkins University, and the doctorate of letters on Mr. John Muir, naturalist and author.

Dr. L. Murbach, head of the department of biology in the high school of Detroit, Mich., has been given a year's leave of absence. His address will be Castleton, Vt.

Dr. Michael F. Guyer of the University of Cincinnati has been appointed professor of zoölogy in the University of Wisconsin.

Professor J. A. Ferguson of the Pennsylvania State College has been appointed professor of forestry in the College of Agriculture of the University of Missouri. The College of Agriculture owns fifty thousand acres of forest lands in the southern part of Missouri. It is planned to utilize these lands as an out-door laboratory for the instruction in practical forestry.

President Taft, upon recommendation of the secretary of the interior, has forwarded to the senate the nomination of Professor Philander P. Claxton, professor of education in the University of Tennessee, as commissioner of education to succeed Dr. Elmer E. Brown, who recently resigned to accept the chancellorship of New York University.

Elliott R. Downing, professor of biology in the Northern State Normal School of Michigan, has been made Assistant Professor of Natural Science in the University of Chicago.

Assistant Professor Henry G. Gale, dean in the Junior College, has been promoted an associate professorship in the University of Chicago.

SCIENCE QUESTIONS.

By Franklin T. Jones,
University School, Cleveland, Ohio.

Our readers are invited to propose questions for solution—scientific or pedagogical—and to answer the questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, University School, Cleveland, Ohio.

Questions and Problems for Solution.

60. *Proposed by J. Hawley Aiken, Springfield, Mass.*

The surfaces of a double convex lens of crown glass have a radius of six inches.

A building 50 feet away is projected on a screen by this lens. (a) How far from the lens should the screen be held? (b) If the image is one inch high, how high is the building?

[Undoubtedly, as a result of recent agitation against the old form of entrance examination, Harvard has instituted a *New Plan*. The following is the first paper in physics under the new plan. Judging from results, has the mission of the agitator been successful? A candid expression of opinion will be appreciated by all teachers, as well as by the Editor.]

Send answers to consecutively numbered problems.

Physics, June, 1911, new plan; (one hour and a half) omit four questions.

All notebooks must be handed in at the laboratory examination and must be claimed when it is over.

In all cases where numerical answers are given, the course of reasoning leading to these answers should be indicated.

The following data may be used if required:

1 cubic foot of water weighs about 62.5 pounds, or about 1,000 ounces.

1 cubic centimeter of air at 21° C. under atmospheric pressure weighs about 0.0012 grams.

1 cubic foot of air under the same conditions weighs about 0.075 pounds, or about 1.2 ounces.

60 miles an hour = 88 feet per second.

61. (*a*) Calculate the volume of the body of a man who weighs 165 pounds and can float practically submerged in fresh water. Name the unit of volume used.

(*b*) If he were to put on a certain life-belt it would float him 1/10 of the volume of his body out of water, the belt itself being wholly submerged. The specific gravity of the life-belt is 0.25. What is its weight?

2. A newspaper clipping in describing a new gas suitable for filling balloons speaks of it as having "a density of 0.225" and "a lifting power of about 1 ounce per cubic foot." What did the writer probably mean by "density"? Give your reasoning.

3. A uniform beam AB, 10 feet long and weighing 50 pounds, rests, horizontal, on two supports, one of which is 3 feet and the other 8 feet from A.

(*a*) What force is exerted on each of the supports?

(*b*) Suppose that a weight of 20 pounds is hung from the end A, what is now the force on each of the supports?

4. (*a*) Define the terms *work* and *power*.

62 (*b*) If an automobile, weighing with its load 2,000 pounds, runs in 3 minutes a distance of 3,300 feet along a grade that rises 5 feet in 100 feet of slope, how much work is done against gravitation?

(*c*) How much *power* is required of the engine in performing the ascent, in excess of the power required to run on a level at the same speed? (Neglect the difference of friction in the two cases.)

63. In the summer of 1909 a professional catcher caught a baseball that had been dropped from a window of the Washington Monument 500 feet above him. The baseball weighed ⅛ of a pound. Neglecting air resistances.

(*a*) How long was the ball in the air?

(*b*) How fast was it going in miles per hour when it reached him?

(*c*) How much kinetic energy did it have when it reached him? (In what units is your answer expressed?)

6. Describe a method of measuring the velocity of sound.

7. Experiments have shown that the quantity of heat required to change one gram of water at 100°C. into steam at 100°C. is equal to the quantity of heat required to raise 5.39 grams of water from 0°C. to 100°C.

How much steam at 100°C. must be admitted into 5,000 grams of water at 20°C., in order that the resulting temperature of water and condensed steam may be 90°C., supposing that all the steam condenses within the water? (Neglect heat absorbed or given out by the containing vessel.)

8. If a mass of gas occupies a volume of 1,440 c.c. at 7°C. and 77 cm. pressure, what will be its volume at 27°C. and 72 cm. pressure?

9. (*a*) State with a diagram the law of the reflection of light.

64. (*b*) What is the shortest plane mirror which when placed flat against a vertical wall will enable a person 6 feet tall to see his entire length? Illustrate with a diagram.

10. Describe, with a diagram, the optical parts of the eye, and tell with explanations what kinds of lenses are used to correct *long-sightedness* and *short-sightedness.*

11. A storage battery of negligible resistance, and with an electromotive force of 2 volts, is connected so as to send current through two resistances in parallel (or multiple). The resistances are 2 ohms and 3 ohms respectively.

(*a*) How much current (name the unit) flows through each of the resistances?

(*b*) How much power (name the unit) is expended in each of the resistances?

12. The resistance of a copper wire 10 metres long and 1 mm. in diameter is about 0.22 ohms. If the same amount of copper is made into a wire ½ mm. in diameter, what will its resistance be?

Solutions.

47. *Proposed by Roy E. Bowman, Alliance, Ohio.*

A wire weighing 0.375 pounds per foot is supported by two posts 160 feet apart. The horizontal pull on the wire is 400 pounds. Find the deflection at the center and the length of the wire.

NOTE.—Mr. Bowman "would like to see a simplified exposition of hyperbolic functions given in the Science Notes" and "to bring it about proposes the above problem."

Solutions have been received from T. M. Blakeslee, Ames, Ia., and L. L. Harding, Suffield, Conn. Neither solution is brief and it seems wise not to publish the complete solutions. They will, however, be mailed to any interested party who will so request the Editor.

48. *Proposed by J. Hawley Aiken, Springfield, Mass.*

A river forty feet wide is dammed. After the water has adjusted itself, it is found to be ten feet deeper on the upper side. Find the unbalanced pressure against the dam.

Solution by the Proposer.

The pressure against a vertical surface depends on the area and the mean depth.

Let x = depth of water on the lower side.

Then $x + 10$ = depth of water on the upper side.

The area pressed on the upper side is $(x + 10)\ 40$.

The mean depth on the upper side is $\frac{x+10}{2}$.

The density of water 62.5 per cu. ft. Therefore the pressure against the dam on the upper side is:

$$(x+10)40 \times \frac{x+10}{2} \times 62.5 = 1250x^2 + 25000x + 125000 \text{ lbs.}$$

The area pressed on the lower side is $40x$. The mean depth on the lower side is $\frac{x}{2}$. Therefore the pressure on the lower side is

$$40x \times \frac{x}{2} \times 62.5 = 1250x^2.$$

Hence the unbalanced pressure against the dam is:

$$1250x^2 + 25000x + 125000 - 1250x^2 =$$
$$25000x + 125000 \text{ lbs. when } x \text{ is the depth on the lower side.}$$

From an entrance examination for Princeton.

49. What is the potential energy of a body whose *weight* is 640 lbs., when it is raised 60 ft.?

The body is allowed to fall freely. What is its kinetic energy after it has fallen 30 ft.? After 60 ft.? Let "g" = 32 ft. per sec. per sec.

Solution by the Editor.

Potential Energy = Force × Distance = 640 × 60 = 38400 foot-pounds.

Kinetic Energy on striking = Potential Energy before it began to fall, hence

Kinetic Energy after falling 30 ft. = 640 × 30 = 19200 foot-pounds.

Kinetic Energy after falling 60 ft. = 640 × 60 = 38400 foot-pounds.

Also solved by J. Hawley Aiken.

50. Steam is admitted to the cylinder of an engine in such manner that the average pressure is 120 lbs. per sq. in. The area of the piston is 54 sq. in. and the length of stroke is 12 inches. How much work can be done during a single complete stroke, assuming that steam is admitted to both sides of the piston in succession?

What is the horse power of the engine when it is making 300 strokes per minute?

Solution by J. Hawley Aiken.

The total pressure against the end of the piston is 120 × 54 = 6480 the length of the stroke 1 ft. hence 6480 ft. lbs. of work each thrust of the piston. If the engine makes 300 such strokes per minutes the H. P. would be:

$$6480 \times 300 \div 33000 = 52.8 + \text{H. P.}$$

51. A stretched wire gives a middle C when plucked. A bridge is put at the middle of the wire, while, at the same time, the tension is made four times what it was. What tone will be produced by either half of the wire?

Solution by the Editor. (*Also by J. Hawley Aiken.*)

When the bridge is placed at the middle of the wire, the latter is one half as long and hence gives C_1 — the octave. When the tension is made four times as great, the vibration frequency will again double and the string give C_2 — the octave above C_1.

52. Calculate by the law of Dulong and Petit the specific heat of a substance whose atomic weight is 108.

Solution by J. H. Aiken.

By Dulong and Petit's law the product of specific heat and atomic weight gives a nearly constant product which is about 6.3; hence the specific heat of this metal is:

$$6.3 \div 108 = .058 +$$

53. Four kilograms of iron at 400°C are dropped into 1 kilogram of broken ice and 3 kilograms of water at 0°C. What is the result? Take .12 as the specific heat of iron and 80 as the heat of fusion of ice.

Solution by J. H. Aiken. His answer is 28°. Is it correct?

54. A loop of wire whose area is 1,000 sq. cm. is removed in .5 second from a magnetic field whose average strength is 2,000 lines per sq. cm. What e. m. f. in volts will be generated?

Solved by J. H. Aiken. Answer, .04 volts.

55. Find the principal focal length of a concave mirror, two of whose conjugate focal lengths are 40 and 50 cm. Find the radius of curvature.

Solved by J. H. Aiken. Answer, 44 4/9 cm.

Both houses of the New York Legislature have passed a bill to appropriate $10,000 for the establishment of a school of sanitary science and public health at Cornell University.

The Harvard Medical School has been bequeathed $22,000 by the will of the late Professor Samuel Hubbard Scudder, the eminent entomologist.

Governor Dix has signed a bill that appropriates $235,000 for the state colleges of Cornell University. The Veterinary College receives $140,000 for a new building and $50,000 is appropriated for a heating plant. This bill is independent of the annual bill for maintenance.

At the Bryn Mawr College commencement announcement was made of a bequest of $150,000 from Phoebe Anna Thorne of New York, who died in 1909, to endow an associate professorship of education and the Phoebe Anna Thorne Model School to be conducted by the college as an experimental high school in connection with a graduate school of education.

THE NEW YORK DOCK PROBLEM has been temporarily settled by the granting of a permit by the United States Government for the extension of the piers of the International Mercantile Marine Company on each side of one of its slips. This will permit ships like the "Olympic" and "Titanic" to go alongside the dock with none of the stern protruding into the North River channel in an unprotected manner; but the permit does not contemplate permanent extension. It is expressly provided that the additions made to the piers shall be of a temporary character which will be allowed to remain in place at the discretion of the Secretary of War. On his order it must be removed immediately.

LARGEST OF FLOWERS.—The largest of all the flowers of the world is said to be the Raffesia, a native of Sumatra, so called after Sir Stamford Raffles. This immense plant is composed of five round petals of a brickish color, each measuring a foot across. These are covered with numerous, irregular, yellowish-white swellings. The petals surround a cup nearly a foot wide, the margin of which bears the stamens. The cup of the Raffesia is filled with a fleshy disk, the upper surface of which is covered with projections like miniature cows' horns. The cup, when free from its contents, will hold about twelve pints. The flower weighs about fifteen pounds, and is very thick, the petals being three quarters of an inch.

PROBLEM DEPARTMENT.

By E. L. Brown,
Principal North Side High School, Denver, Colo.

Readers of this magazine are invited to send solutions of the problems in which they are interested. Problems and solutions will be duly credited to their authors. Address all communications to E. L. Brown, 3435 Alcott St., Denver, Colo.

ALGEBRA.

249. *Proposed by John Gaub, Ithaca, N. Y.*

Solve $18^{4(3-x)}=(54\sqrt{2})^{3x-2}$

I. *Solution by J. M. Gallagher, Boston, Mass., and R. E. Scott, St. Louis, Mo.*

Since $18=(3\sqrt{2})^2$ and $54\sqrt{2}=(3\sqrt{2})^3$, we may write the given equation thus, $(3\sqrt{2})^{8(2-x)}=(3\sqrt{2})^{3(3x-2)}$. Hence, $8(2-x)=3(3x-2)$ and $x=22/17$.

II. *Solution by E. M. Dow, Brighton, Mass., and R. E. Bowman, Alliance, Ohio.*

Taking the logarithm of each member,

$$4\ (2-x)\ \log 18 = (3x-2)\ (\log 54 + \tfrac{1}{2}\log 2),$$

$$\text{or } 4\ (2-x)\ (\log 2 + 2\log 3) = (3x-2)\ (\log 2 + 3\log 3 + \tfrac{1}{2}\log 2),$$

$$\text{or } 8\ (2-x)\ (\log 2 + 2\log 3) = 3\ (3x-2)\ (\log 2 + 2\log 3) \ldots\ldots (2)$$

Dividing (2) through by $(\log 2 + 2\log 3)$,

$$8\ (2-x) = 3\ (3x-2),$$

which gives $x=\dfrac{22}{17}$.

250. *Selected.*

If a, b, c are positive and unequal, show that the roots of

$$x^3-(a^2+b^2+c^2)x-2abc=0$$

are real and unequal, one positive and the other two negative.

I. *Solution by N. Anning, Chilliwack, B. C.*

The equation $t^3 + pt + q = 0$ has three real roots if

$$\frac{q^2}{4}+\frac{p^3}{27}<0.$$

Putting $p=-(a^2+b^2+c^2)$ and $q=-2abc$, the given equation has three real roots since

$$(a^2+b^2+c^2)^3 > 27\,a^2b^2c^2.$$ See Prob. 254.

If $f(x)=x^3-(a^2+b^2+c^2)\,x-2abc$,

$f(+\infty)$ is positive and $f(o)$ is negative. Hence there is an odd number of real positive roots. By Descartes' rule there cannot be more than one. Therefore there is just one. Since x is not a factor of $f(x)$ there is no zero root and the remaining pair of roots must be negative.

To show that the roots are unequal suppose the contrary and let $f(x) = (x-m)\ (x-n)\ (x-n)$.

Then $m + 2n = 0$,

$$n^2 + 2mn = -(a^2+b^2+c^2),$$

and $mn^2 = 2abc$.

Elimination of m and n from these three equations gives $(a^2+b^2+c^2)^3 = 27\,a^2b^2c^2$, which is impossible.

Hence when a, b, and c are positive and not all equal the roots of $f(x)=0$ are real and unequal, one positive and the other two negative.

II. *Solution by H. E. Trefethen, Kent's Hill, Me.*

Put $3s^2 = a^2 + b^2 + c^2$, $p^3 = abc > 0$, and the given equation becomes $x^3 - 3s^2x - 2p^3 = 0$ . . . (1) or $x(x^3 - 3s^2) = 2p^3$ . . . (2). By problem 254 $(a^2 + b^2 + c^2)^3 > 27\,a^2b^2c^2$ (unless $a = b = c$) Hence $s^6 > p^6$ and $s > p > 0$ . . . . (3).

If r is a root of (1), $x - r$ is an exact divisor of the first member and we have $(x - r)(x^2 + rx + r^2 - 3s^2) = 0$. Hence $x^2 + rx + r^2 - 3s^2 = 0$ and $x = -r/2 \pm \sqrt{3s^2 - 3r^2/4}$.

If $3r^2/4 = 3s^2$, $r = 2s = x$, the other two roots are equal, and by (1) $s = p$. But as this contradicts (3) there are no equal roots.

If $r > 2s$, the other two roots are imaginary. But this, too, is impossible, for by (2) when $x > s\sqrt{3}$, p increases as x increases and thus $p > s$. Hence by (3) there can be no imaginary roots. Therefore the roots are real and unequal.

Again since the sum of the roots $= 0$ and their product $= 2p^3 > 0$, one root must be positive and the other two negative.

Evidently in the conditions stated the positive root lies between $2s$ and $s\sqrt{3}$ and the negative roots between 0 and $-s\sqrt{3}$.

If $x^3 + 3s^2x \pm 2p^3 = 0$, two of the roots are imaginary. For as above we find $x = -r/2 \pm \sqrt{-3s^2 - 3r^2/4}$ and hence whatever the values of s and r the other two roots are imaginary.

251. *Proposed by Ira M. DeLong, Boulder, Colo.*

Let $a\sqrt[m]{\mathrm{A}}$, $b\sqrt[n]{\mathrm{B}}$ be equal simple surds in their simplest form; prove $a=b$, $\mathrm{A}=\mathrm{B}$, $m=n$.

Solution by Olaf K. Lie, Richmond, Mass.

(1). If $m \neq n$, suppose $m < n$ and raise both sides to the mth power. Then $a^m\,\mathrm{A} = b^m\,\mathrm{B}^{m/n}$. But $\mathrm{B}^{m/n}$ is an irrational number, since by the given conditions m times the number of equal factors in B, or any divisor of B, cannot $= n$, or any multiple of n. Thus we have a rational number $a^m\mathrm{A} = b^m\mathrm{B}^{m/n}$ an irrational number, which is impossible. Hence $m \not< n$. In the same way it may be shown that $m \not> n$. Therefore $m = n$ and we have

(2). $a\sqrt[n]{\mathrm{A}} = b\sqrt[n]{\mathrm{B}}$. Dividing by $\sqrt[n]{\mathrm{A}}$, $a = b\sqrt[n]{\mathrm{A}/\mathrm{B}}$, which is impossible unless $\mathrm{A} = \mathrm{B}$. Hence we have

(3). $a\sqrt[n]{\mathrm{B}}, = b\sqrt[n]{\mathrm{B}}$ and $a = b$.

Geometry.

252. *Proposed by N. Anning, Chilliwack, B. C.*

If a triangle have a point at which all the sides subtend equal angles, find the distance of this point from the vertices.

Solution by Artemas Martin, Washington, D. C.

Let a, b, c be the sides of the triangle ABC, and x, y, z the distances from the vertices to the point P within the triangle at which the sides subtend equal angles of 120°; then we have the following equations of condition,

$$x^2 + xy + y^2 = c^2 \quad . \quad . \quad . \quad . \quad (1),$$
$$x^2 + xz + z^2 = b^2 \quad . \quad . \quad . \quad . \quad (2),$$
$$y^2 + yz + z^2 = a^2 \quad . \quad . \quad . \quad . \quad (3).$$

Subtracting (3) from the sum of (1) and (2),

$$2x^2 + xy + xz - yz = b^2 + c^2 - a^2 \quad . \quad . \quad . \quad . \quad (4).$$

Subtracting the square of (4) from 4 times the product of (1) by (2), and extracting the square root of one third of the remainder,

$xy + xz + yz = \pm \frac{1}{3}\sqrt{[12b^2c^2 - 3(b^2 + c^2 - a^2)^2]}$ . . . . (5)

Adding three times (5) to the sum of (1), (2), and (3), and extracting square root of twice the sum,

$$2(x+y+z) = \pm\sqrt{\left\{2(a^2+b^2+c^2) \pm 2\sqrt{[12b^2c^2 - 3(b^2+c^2-a^2)^2]}\right\}}. \quad . . . . (6)$$

Subtracting twice (3) from the sum of (1), (2), (3) and (5), and dividing the remainder by (6),

$$x = \frac{b^2+c^2-a^2 \pm \frac{1}{3}\sqrt{[12b^2c^2 - 3(b^2+c^2-a^2)^2]}}{\pm\sqrt{\left\{2(a^2+b^2+c^2) \pm 2\sqrt{[12b^2c^2 - 3(b^2+c^2-a^2)^2]}\right\}}}.$$

By simply permuting the letters we have

$$y = \frac{a^2+c^2-b^2 \pm \frac{1}{3}\sqrt{[12b^2c^2 - 3(a^2+c^2-b^2)^2]}}{\pm\sqrt{\left\{2(a^2+b^2+c^2) \pm 2\sqrt{[12a^2c^2 - 3(a^2+c^2-b^2)^2]}\right\}}},$$

$$z = \frac{a^2+b^2-c^2 \pm \frac{1}{3}\sqrt{[12a^2b^2 - 3(a^2+b^2-c^2)^2]}}{\pm\sqrt{\left\{2(a^2+b^2+c^2) \pm 2\sqrt{[12a^2b^2 - 3(a^2+b^2-c^2)^2]}\right\}}}.$$

II. *Solution by N. Anning, Chilliwack, B. C.*

If each of the angles of the triangle is less than 120°, there will be a point within the triangle at which each side subtends an angle of 120°.

Let a, b, c, and $\triangle$ be the sides and area of the triangle and let x, y, and z be the distances required, x being measured from A, etc.

$$a^2 = y^2 + z^2 - 2yz \cos. 120°$$
$$= y^2 + z^2 + yz. \quad (1)$$
$$\text{Similarly, } b^2 = y^2 + x^2 + yx \quad (2)$$
$$\text{and } c^2 = x^2 + y^2 + xy \quad (3)$$

It may be shown that these three equations are independent and consequently sufficient for determining x, y, and z. The solution is simplified by using the further relation.

$$\triangle = \tfrac{1}{2}xy \sin 120° + \tfrac{1}{2}yz \sin 120° + \tfrac{1}{2}zx \sin 120°,$$
$$\text{or } xy+yz+zx = 4\triangle/\sqrt{3}. \quad (4)$$

Equation (4) is not independent and might have been derived from (1), (2), and (3).

Adding three times (4) to the sum of (1), (2), and (3), dividing by 2 and extracting the square root gives

$$x + y + z = [\tfrac{1}{2}(a^2 + b^2 + c^2 + 4\triangle\sqrt{3})]^{\frac{1}{2}} = D. \quad (5)$$

Adding (1), (2), and (3),

$$2(x^2 + y^2 + z^2) + xy + yz + zx = a^2 + b^2 + c^2 \quad (6)$$

Squaring (5)

$$x^2 + y^2 + z^2 + 2(xy + yz + zx) = \tfrac{1}{2}(a^2 + b^2 + c^2) + 2\triangle\sqrt{3} \quad (7)$$

Adding (6) and (7), dividing by 3,

$$x^2 + y^2 + z^2 + xy + yz + zx = \tfrac{1}{2}(a^2 + b^2 + c^2) + 2\triangle/\sqrt{3},$$
$$\text{or } x(x + y + z) + y^2 + yz + z^2 = \tfrac{1}{2}(a^2 + b^2 + c^2) + 2\triangle/\sqrt{3} \quad (8)$$

From (1), (5), and (8)

$$x = [\tfrac{1}{2}(b^2 + c^2 - a^2) + 2\triangle/\sqrt{3}]/D$$

The values of y and z may be obtained similarly.

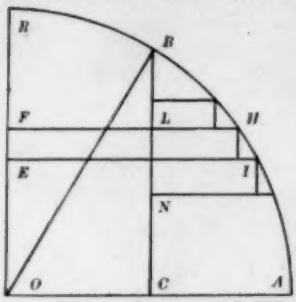
Note: $x + y + z$ is the distance from any vertex of the triangle to the vertex of the equilateral triangle described outward on the opposite side.

253. *Selected by H. E. Trefethen, Kent's Hill, Me.*

A man built an oven to burn charcoal in on a circular bottom, ten feet in diameter. While building it he kept one end of a pole, ten feet long, always against the place he was working at, and the other end in that point of the circumference of the bottom opposite to him. Find the capacity of the oven *by the methods of pure geometry* (without the use of calculus or *the center of gravity*).

Solution by the Proposer.

AOR is a quadrant. AOB is a sextant. Let the required volume $= v$ be generated by the revolution of the semi-segment AHBC about BC as axis. Put semi-chord BC $= c$, area of AHBC $= K$, and V $=$ the volume generated by the revolution of AHBC about OR as axis.



(1) By a familiar theorem in solid geometry $V = 2\pi c^3/3$.

(2) To find $V - v$, divide AHBC into rectangular strips and let NLHI be any one of these rectangles. Put HL $= a$, FL $= d$, HI $=$ EF $= h$. Let EFHI revolve about OR as axis and put U, U′, U″ for the volumes generated by NLHI, EFHI, EFLN.

Then—

$$U' = \pi h(a + d)^2,\ U'' = \pi h d^2,\ U' - U'' = U = \pi h(a^2 + 2ad).$$

Now let NLHI revolve about BC. The volume generated $= \pi a^2 h = u$. Hence $U - u = 2\pi d.ah$. The area of NLHI $= ah$.

Now put k, k_1, k_2, etc., for the areas of several rectangles; U, U_1, U_2, etc., for the corresponding volumes generated about axis OR; u, u_1, u_2, etc., for those generated about BC. As already proved—

$$2\pi dk = U - u,\ 2\pi dk_1 = U_1 - u_1,\ 2\pi dk_2 = U_2 - u_2, \text{ etc.}$$

Adding $2\pi d(k + k_1 + k_2 + \text{etc.}) = U + U_1 + U_2 + \text{etc.} - (u + u_1 + u_2 + \text{etc.})$, and taking the limits as the number of rectangles is indefinitely increased, $2\pi dK = V - v$.

$U_1 + U_2 + \text{etc.} - (u + u_1 + u_2 + \text{etc.})$, and taking the limits as the number of rectangles is indefinitely increased, $2\pi dK = V - v$.

(3) Therefore $v = V - 2\pi dK$ and by (1) $v = 2\pi c^3/3 - 2\pi dK = 2\pi(c^3/3 - dK)$.

(4) In the given case we have OA $=$ OB $=$ AB $= 10$, BC $= c = 5\sqrt{3}$, OC $= d = 5$, area AHBC $= K\ 100\pi/6 - 25\sqrt{3}/2$. Substituting in (3) we find $v = 125\pi(9\sqrt{3} - 4\pi)/3 = 395.7216$ cu. ft.

(5) The theorem proved in (2) stated generally is—

If any plane figure, no part of which is between two parallel lines in its plane, revolve in succession about each of them as axes, the difference in the volumes of the solids thus generated is equal to the area of the generating figure multiplied by 2π times the distance between the axis.

(The figure may be entirely separate from the axes, or may have a side for one of the axes as in (2), or may have a vertex on one of the axes. In the proof the figure may be divided into triangles as well as rectangles.)

II. *Solution by Philip Fitch, Denver, Colo.*

Divide the solid into layers by passing planes through it parallel to its base. Let h=height of solid $=5\sqrt{3}$ feet; d=thickness of a layer; n=total number of layers; $nd=h$; V=volume of solid; v_1, v_2, v_3, ...volumes of 1st, 2nd, 3rd.....layers respectively, beginning at the base.

Then $v_1 = \pi \cdot 25d$, $v_2 = \pi\left(\sqrt{100 - d^2} - 5\right)^2 d$, $v_3 = \pi\left(\sqrt{100 - (2d)^2} - 5\right)^2 d$ ..... $Vn = \pi\left(\sqrt{100 - (nd)^2} - 5\right)^2 d$.

$$V = v_1 + v_2 + v_3 \ldots\ldots v_n,$$

$$= \pi d\left\{25 + \left[\sqrt{100 - d^2} - 5\right]^2 + \left[\sqrt{100 - (2d)^2} - 5\right]^2 + \ldots\ldots \left[\sqrt{100 - (nd)^2} - 5\right]^2\right\}$$

$$= \pi d\left\{25 - d^2[1^2 + 2^2 + 3^2 + \ldots\ldots n^2] - 10\left[\sqrt{100 - d^2} + \sqrt{100 - (2d)^2} + \ldots \sqrt{100 - (nd)^2}\right] + 125n\right\}$$

$$=\pi d\left\{[5n+1]25-d^2[1^2+2^2+3^2\ldots.n^2]-10\left[\sqrt{100-d^2}+\sqrt{100-(2d)^2}+\sqrt{100-(nd)^2}\right]\right\}$$

Expanding,

$$\sqrt{10^2-d^2}=10-\frac{d^2}{2\cdot 10}-\frac{d^4}{8\cdot 10^3}-\frac{d^6}{16\cdot 10^5}-\ldots\ldots\ldots$$

$$\sqrt{10^2-(2d)^2}=10-\frac{4d^2}{2\cdot 10}-\frac{16d^4}{8\cdot 10^3}-\frac{64d^6}{16\cdot 10^5}-\ldots\ldots\ldots$$

$$\sqrt{10^2-(nd)^2}=10-\frac{n^2d^2}{2\cdot 10}-\frac{n^4d^4}{8\cdot 10^3}-\frac{n^6d^6}{16\cdot 10^5}-\ldots\ldots\ldots$$

$$\therefore V=\pi d\left\{[5n+1]25-d^2[1^2+2^2+3^2+\ldots\ldots n^2]-10\left[10n-\frac{d^2}{2\cdot 10}(1^2+2^2+3^2+\ldots\ldots n^2)-\frac{d^4}{8\cdot 10^4}(1^4+2^4+3^4+\ldots.n^4)-\frac{d^6}{16\cdot 10^5}(1^6+2^6+3^6+\ldots.n^6)-\ldots.\right]\right\}$$

$$=\pi d\left\{[5n+1]25-d^2\left[\frac{n(n+1)(2n+1)}{6}\right]-10\left[10n-\frac{d^2}{2\cdot 10}\left(\frac{n(n+1)(2n+1)}{6}\right)-\frac{d^4}{8\cdot 10^3}\left(\frac{6n^5+15n^4+10n^3-n}{3}\right)-\frac{d6}{16\cdot 10^5}(\ldots.)-\ldots.\right]\right\}$$

Now $n \doteq \infty$ as $d \doteq 0$.

$$V=\pi\left\{125nd-\frac{n^3d^3}{3}-\frac{50nd}{2}-500\left[\frac{nd}{10}+\tfrac{1}{2}\frac{n^3d^3}{3\cdot 10^3}+\frac{n^5d^5}{2\cdot 4\cdot 5\cdot 10^5}+\ldots.\right]\right\}$$

$$=\pi\left\{125h-\frac{h^3}{3}-\frac{50h}{2}-500\sin^{-1}\frac{h}{10}\right]$$

$$=\pi\left\{125\cdot 5\sqrt{3}-125\sqrt{3}-125\sqrt{3}-\frac{500\pi}{3}\right]$$

$$=395.7 \text{ cu. ft.}$$

Credit for Solutions Received.

Algebra 249. N. Anning, R. E. Bowman, E. M. Dow (2 solutions), J. M. Gallagher (2 solutions), J. G. Gwartney, A. M. Harding, Emma Hyde, S. J. Kiehl, O. K. Lie, Artemas Martin (2 solutions), R. E. Scott, H. E. Trefethen. (14).

Algebra 250. N. Anning, A. M. Harding, H. E. Trefethen. (3)

Algebra 251. O. K. Lie, H. E. Trefethen. (2)

Geometry 252. N. Anning, Artemas Martin, H. E. Trefethen. (3)

Geometry 253. P. Fitch, H. E. Trefethen. (2)

Total number of solutions, 24.

PROBLEMS FOR SOLUTION.

Algebra.

259. *Proposed by R. E. Bowman, Alliance, O.*

Solve:

$$\left(3-\frac{6y}{x+y}\right)^2+\left(3-\frac{6y}{x-y}\right)^2=82. \qquad (1).$$

$$xy=2. \qquad (2).$$

260. *Proposed by A. C. Smith, Denver, Colo.*

The sum of three numbers in G. P. is 42. The difference between the squares of the first and second is 60. What are the numbers? (Hawkes' Advanced Algebra, Ex. 36, p. 140.)

Geometry.

261. *Selected.*

If A, B, C are three collinear points, and if K is any other point, prove

that the circumcenters of the triangles KBC, KCA, KAB are concyclic with K.

262. *Proposed by H. E. Trefethen, Kent's Hill, Me.*

In a quadrant a circle is inscribed and in the space included by this circle the arc of the quadrant and one of its sides a smaller circle is inscribed. Show how to construct the two circles.

263. *Proposed by Olaf K. Lie, Richmond, Mass.*

Construct a triangle, having b, c, and r.

Miscellaneous.

264. *Suggested by Anon.*

"The most common divergences (of leaves on a stem) are the following: $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$, $\frac{8}{21}$, $\frac{13}{34}$, etc. The value of the different fractions varies between $\frac{1}{2}$ and $\frac{1}{3}$ while always approaching a divergence angle of 137° 30′ 28″." (Strassburger, Noll, Schenck and Karsten's Botany, p 42). Prove the two statements of the second sentence.

SULPHUR AND PYRITE INDUSTRY.

United States Geological Survey Report Shows Great Growth in Production During Last Ten Years.

From a production of but 3,147 long tons of sulphur, valued at $88,100, to an output of 239,312 long tons, valued at $4,432,066 in a period of ten years is a long stride, but this is the growth that has taken place in the sulphur industry in the United States since 1900. Futhermore, it was not so very long ago that the United States sent abroad more than $3,000,000 annually for native sulphur, by far the larger part of which came from Sicily. In 1909 the United States not only produced enough sulphur for her own needs but exported 37,142 long tons, valued at $736,928, as compared with an importation of various grades valued at $549,632, leaving a balance of trade in favor of this country of nearly $200,000.

The Frasch Process in Louisiana.

The great reversal of conditions whereby the United States has become a dominant factor in the sulphur industry of the world is largely due to the inventive genius of Herman Frasch, an American, of Cleveland, O. The process whereby sulphur is obtained in practically pure condition from the earth is known from the inventor's name as the Frasch process and is employed in working the great sulphur deposits in Louisiana. Briefly, the process is as follows: A well is driven in much the same manner as a gas or oil well is sunk, and into it are placed several concentric lines of pipe. Superheated water introduced through the outer pipe melts the sulphur, which may be several hundred feet below the surface. Hot compressed air is then forced through the smallest of the pipes. This forms an aerated emulsion with the molten sulphur, which is forced out by hydrostatic pressure between the remaining pipes and discharged in a purified form into large vats where cooling, solidification, and feeding go on simultaneously. The sulphur is then broken up, shipped by rail to the Gulf Coast, loaded on ships by machinery, and transported to Eastern coast ports.

REAL PROBLEMS IN GEOMETRY.

EDITED BY THE REAL PROBLEM COMMITTEE OF THE C. A. S. & M. T.,

JAMES F. MILLIS, *Chairman*,

Francis W. Parker School, Chicago,

The following problems are taken from sets of examination questions sent to the Real Problem Committee by E. L. Piesse, Esq., B.Sc., examiner for the University of Tasmania. Mr. Piesse has used such problems in his examinations for some years. These problems are here printed in the hope that they may suggest to teachers of secondary mathematics in this country similar problems of local application.

Problems.

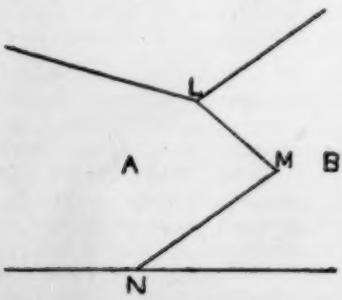
1. B, V, and N are three peaks whose positions are known accurately. Their distances from two lines OE (running east and west) and OS (running north and south) are as follows:

	Distance south of OE (miles)	Distance east of OS (miles)
B	6.4	3.2
V	3.2	24.8
N	16.8	30.4

The position of a peak X is determined by observations at X of the angles BXV, VXN, which are 92° and 55° respectively. B, V, N, and X being assumed to be in the same plane, find from a drawing to scale the distances of X from OE and OS.

If through an instrumental error the angles BXV, VXN are observed to be 94° and 57° respectively, find from the drawing the resulting error in the position of X (that is, the distance in miles between the true and the erroneous positions of X).

2. The boundary between two adjoining properties A and B is a crooked fence LMN (the parts LM, MN each being straight).



Show with proof how to find the line of a straight boundary fence through L to replace the crooked fence, so that the areas of the properties A and B shall remain unaltered.

3. A, B are two beacons on a coast-line; S is a shoal off the shore; and the angle ASB is known to be 120°. Show that a vessel V sailing along the coast will keep outside the shoal if the angle AVB is always less than 110°.

Prove a property of the circle that you used in proving that the ship will clear the shoal.

4. The banks of a river a quarter of a mile wide are parallel straight lines running east and west. B is a village two miles north of the northern bank, and A is a village one mile and a half south of the southern bank, and A is one mile east of the north and south line through B. A man goes from B to A, crossing the river in a boat. The current in the river carries the boat down stream so that, from whatever point on the northern bank

the boat starts, its course is a straight southwesterly line. Find by the method of parallel translation or otherwise, the length of the shortest path from B to A.

5. Brown Mountain is 29 miles due west of the Bishop and Clerk. Ben Lomond is 69 miles from the Bishop and Clerk and 66 miles from the Brown Mountain. Find by calculation whether Ben Lomond lies to the east or to the west of the north and south line passing through Brown Mountain.

6. Justify the following method for erecting a flagstaff in a vertical position on level ground: Measure off 4 yards up the pole, and attach to the point thus obtained two ropes each 5 yards long. Peg down the other end of each rope at a distance of 3 yards from the foot of the pole. When will this method fail?

7. Four narrow strips of cardboard are fastened together by paper fasteners so as to form a parallelogram hinged at the corners, some of the sides extending beyond the corners. Four points A, B, C, D are taken in a straight line, one on each side or side produced. Show that however the shape of this hinged parallelogram be altered by moving the sides about the corners the four points A, B, C, D remain in a straight line, and that the ratios AB : BC : CD remain unaltered.

The pantograph is an instrument of which the essential part is an arrangement of this kind. One of the points A, B, C, D being kept fixed, show how the pantograph can be used to draw a reduced or enlarged figure similar to a given figure.

8. A steamer is approaching the south coast of Tasmania at night. When Maatsuyker and South Bruni lighthouses are first sighted they are observed to subtend an angle of 120°. A second observation is taken when the steamer is 4 miles N. E. of her first position and the lighthouses are found to subtend an angle of 130°. South Bruni is 40 miles E., N. E. of Maatsuyker. Show how to determine the steamer's position on a chart by a geometrical construction.

(A general solution of this problem, not involving the particular distances and angles given, will be accepted. If you have compasses and protractor, draw the figure accurately and measure the steamer's distances from South Bruni and Maatsuyker.)

9. "It is said by some that the view from Mt. Barrow extends right over Bass Strait to the high land on Wilson's Promontory, which can be seen on a clear day."—*Handy Guide to Northern Tasmania.*

The height of Mt. Barrow is 4644 feet, and that of Mt. Latrobe, the highest point on Wilson's Promontory, is 2,434 feet. The distance apart of the two mountains is about 150 miles. Assuming that light travels in straight lines, and (in order to allow for refraction) that the radius of the earth, regarded as a perfect sphere, is 7/6 its actual radius of 4,000 miles, and that there are no intervening land masses, determine whether the statement quoted above is correct.

10. On a flat side of a board a curve is drawn which is said to be a circle. A small hole has been made through the board, cutting away the central part of the figure. Find a method to test, by drawing and measurement on the board, whether the curve is a circle.

ERRATUM.

The book on "The Hindu Arabic Numerals" mentioned on page 508 of the June issue should have been credited to David Eugene Smith and L. C. Kaspinski.

EASTERN ASSOCIATION OF PHYSICS TEACHERS.

The fifty-ninth meeting of this association was held Saturday, June 3, at Groton School, Groton, Mass. It was called to order at 11 A. M. by President Griswold, who introduced the Rev. Sharrard Billings, who welcomed the Association to the school. He spoke complimentary about the work it was doing and the influence it could and does exert on science teaching in secondary schools.

Mr. Le Sourd, chairman of the committee on new apparatus, described some new apparatus from the Central Scientific Company of Chicago. He had on exhibition an Ames and Bliss wave apparatus and also a set of Gamot bells, consisting of two octaves of flat metal rods so mounted as to produce clear and prolonged tones. Mr. Hathway from the committee on magazine literature presented a report mentioning the principal physics articles in some of the leading magazines. The committee on current events followed with an interesting account of some of the new and interesting occurrences which have recently taken place in the physics world.

Mr. S. Warren Sturgis of Gorton School read a paper on "Cathedral Bells and Bell Pealing;" this was most helpful and interesting.

Mr. Roswell Parish gave a paper on "Demonstration of Chladrn's Figures." The paper was illustrated by a number of experiments which can be profitably used in order to make clear to the pupil the fact that a body can vibrate as a whole and in parts at the same time.

Mr. H. L. Crane of Groton School gave a talk on the "Physics of the Pipe Organ," which was at once helpful to everyone present. The speaker went into considerable detail concerning the construction and action of the organ.

Following the luncheon in the library of the school, Professor Sabine of Harvard University gave an account of some recent experiments on the "Interference and Resonance in Architectural Acoustics." The speaker told how it was possible to record the intensity of sound continuously along a fine spiral from the walls to the center of a room while a steady source of known intensity is sounded at a particular part of a room. From these records it is possible to plot contour lines showing the distribution of the vibration in the room.

The last subject on the program was an informal talk by Mr. John C. Packard of Brookline on "The Mechanism of the Ear." He illustrated his talk with some slides, which explained the mechanism of the ear clearly. He also explained the construction and use of an audiometer.

(*Abstracted from the report.*)

SEVENTH ANNUAL MEETING OF THE MISSOURI SOCIETY OF TEACHERS OF MATHEMATICS AND SCIENCE.

The seventh annual meeting of the Missouri Society of Teachers of Mathematics and Science met May 5, 6, 1911, at Columbia, Mo. In addition to the routine business and the election of officials, the following program was carried out in the mathematics section. The opening address was given by President George Melcher on "Mathematics in the Elementary Grades." The paper was strong in presenting the needs in the elementary course.

Perhaps the most striking feature of the program was the development of the idea of presentation of mathematics from the standpoint of the real or applied problem. Miss Adrians Liepsner of the Westport High School, Kansas City, led this work with a paper on the "Necessity and the Possibility

of Interesting High School Students in Mathematics." Miss Liepsner presented some of the Westport students' work, which was highly creditable and showed how it was possible to apply geometry to designing and other activities. The basis of the real problem question was outlined in a thorough paper by Mr. W. S. Monroe of the university faculty, Columbia. Mr. Monroe has carried on some extensive experimenting in the real problem field with classes in the first year high school, with particular respect to algebra. His paper entitled "An Experiment in First Year Algebra" called forth some pertinent discussion, which led to the appointment of a committee to investigate the field of possible problem material and see what could be done toward advancing the idea in the high schools in Missouri. Another important feature of the program was a paper by Mr. H. C. Harvey, State Normal School, Kirksville, on "Articulation of Some of the Principal Topics of Arithmetic."

The keynote of the meeting was the making of mathematical teaching more economical, more usable, and more useful. A very stimulating meeting.

Byron Cosby, Retiring Secretary, Kirksville, Mo.

AN EDUCATIONAL BILL.

It is fortunate for the general welfare of the country that we have men in Congress who are intensely interested in all phases of education. Frequently measures are introduced in which friends of education should become thoroughly active. Hon. Carroll S. Page, member of the United States Senate, has recently introduced a bill having in view the extension of government and to the states in promoting a better system of education along agricultural and industrial ideas and in home economics in secondary schools; in maintaining instruction in these vocational subjects in state normal schools; in maintaining extension departments in state colleges of agriculture and mechanic arts; and to appropriate money and regulate its expenditure.

If those reading this will write their senator or representative for a copy of the bill, familiarize themselves with it and then talk or write to their friends who are interested in secondary school instruction in agriculture, there will be little doubt but what this meritorious bill will pass.

HUMAN ENGINEERING is a new profession called into being by conditions in the industrial world. This profession bears the same name as a publication, and seemingly has to do with the human side of industry and the conservation of human energy.

THE HAMBURG DOUBLE TUNNEL which has been in process of construction for the past three years under the River Elbe at Hamburg, Germany, will be opened this year. It is about fifteen hundred feet long, and the cost of the two bores will be close to $2,500,000. Each bore has a roadway for automobiles and other wheeled traffic, and two footpaths. One bore is used for the up traffic and the other for down traffic.

CORRUGATED PROPELLERS effectually arrest the centrifugal action of the water along the blade, thus preventing slip and increasing the driving power of the machinery without increasing the revolutions or the consumption of coal. The corrugations are part of a true helix which enters the water without the slightest shock. The corrugated propellors are made in sizes suitable for motor boats as well as for ocean steamships.

RUFUS PHILLIPS WILLIAMS: SCIENTIST, AUTHOR, TEACHER.

For the first time in our history we are called upon to record the death, on August 23, of one of our associate editors. Mr. Williams has been in editorial charge of the department of Metrology since the birth of this Journal. To him, through these columns and in other directions, is due the great advance which has been made among thinking people of the recognition of the value of the metric system of measurements. His sterling worth can best be told by giving the following tribute from one of his former pupils:

Fortunate indeed is the man who is for the greater portion of his life in close personal contact with youth of from fourteen to eighteen years.

The personal element introduced into the best teaching plays a far more important role in developing character than either teacher or pupil can possibly imagine. English High School boys of early as well as recent years will all feel a deep sense of personal loss in the passing away of Rufus Phillips Williams, a teacher so conscientious, so painstaking, so thorough that no one passing through his hands could fail to carry forever an impression of the nobility of science, the love of learning and the value of doing at least one thing well.

Those of us who have enjoyed his warm personal friendship for many years feel bereft of a true and sincere friend, a wise counselor, and a stimulating and encouraging associate.

The service of Mr. Williams to science in general and to chemistry in particular is one that but few men are privileged to perform. In pedagogy he developed methods of teaching that he has followed many years with most marked success. He instituted and vitalized the New England Association of Chemistry Teachers and the teaching force in this whole section will long miss his energetic presence, his keen analysis of all situations, and his enthusiastic promotion of all agencies leading towards the development of teaching his beloved science, chemistry.

A sturdy disciplinarian and with a full sense of the dignity of the class room and the importance of study, the impressions of the value of character left in his "boys" have influenced thousands to better, nobler, upright manhood. Singularly reticent and modest whenever his own accomplishments were under discussion he never tired of recounting the successes of his former students, little realizing that his own influence had played no minor role in their successes.

Those of us who are clearly cognizant of inspiring moments with him either in early years as a student or in later years as more intimate friends —moments when his clear, scientific mind has thrown an illuminating light on perplexing problems of either life, pedagogy or science, will all feel that although he has gone to better things and we shall sorely miss his counsel, yet he has left us impressions that will be everlasting.

Carnegie Institution of Washington FRANCIS G. BENEDICT.
Nutrition Laboratory, Boston.

ELECTRIC LAMPS AND WIRELESS TELEGRAPHY.—There is reported in Germany a curious instance of the capture of a wireless telegraph message by an electric lamp. An inhabitant of Brunswick, who had such a lamp in his laboratory, was surprised to observe that its brilliancy varied with the unmistakable rhythm of Morse signals. Not only did the light vary but the sounds always given forth by the arc of the lamp varied in consonance. With a little attention he was able to decipher a message which was being sent out from a radio-telegraphic station three kilometers—nearly two miles—away.

A SMALL FOREST RESERVE FOR ILLINOIS.

Simeon West, a wealthy resident of McLean County, Illinois, has given to the county a virgin timber tract of twenty acres. Should the county ever undertake to use this tract for any other purpose than a public park or forest, the title will revert to the heirs of the donor. Mr. West hopes that his action will be an inspiration to others to do likewise.

THE DELAWARE & HUDSON RAILROAD'S FORESTRY WORK.

At the nursery of the Delaware & Hudson Railroad Company at Bluff Point, Lake Champlain, the railway is growing thousands of Norway spruce and other conifers for use in reforesting waste land in the Adirondacks and other places along the Saratoga and Champlain divisions. At Oneonta the company is growing red oak seedlings for the purpose of providing timber for ties. The company has decided to devote three acres to a nursery for the growing of red oak seedlings. The company plans to plant over one million red oak trees, most of which will be furnished from this nursery. The industrial department of the Delaware & Hudson in collaboration with the superintendent of woodlands, Mr. Bristol, is preparing a booklet to be issued this spring in which the subject of planting trees is to be brought to the attention of farmers and others along the company's line. In addition to the distribution of the pamphlet the company will offer to farmers and small land owners the advice and instruction of Mr. Bristol free of charge.

THE BILTMORE FOREST SCHOOL.

The Biltmore Forest School with fifty students has returned to America after a successful winter session in Germany. The foresters-to-be arrived in New York on March 27. In the German forests the results of German sylviculture, forest management, forest finance, forest policy, and forest protection were seen and studied from beginning to end. In the manufacturing institutions there was observed a high quality of work as well as the small quantity of the output; also the economy practiced under the pressure of high stumpage prices. The students had impressed upon them that conservative forestry is practiced wheresoever it pays to conserve the forests; that stumpage is being raised wherever the price of the tree pays for the cost of raising the tree; that unlimited competition is detrimental to forestry of a conservative type.

The field work for the month of March included two of the most interesting trips of the winter. In the Spessart Mountains, a district of Bavaria known as the home of the best white oak on earth, were seen oaks up to four hundred years old that command a stumpage price of $170 per thousand feet board measure, on an average. Individual trees—numbers of them—have a stumpage value exceeding $500. The texture of the timber seems to be particularly fine. The owners are in the habit of putting yearly on the market a limited number of trees only, so as to maintain the demand. This arrangement preserves the forests and a permanent supply of oak timber.—*American Forestry.*

The governor of Pennsylvania has approved a bill giving an appropriation to the Schools of Mines, Engineering, etc., of the University of Pittsburg, amounting to $400,000.

Harvard University has received from the class of '86 $100,000 to be used without restriction for the purposes of the college.

BOOKS RECEIVED.

Systematic Handbook of Volumetric Analysis. By Francis Sutton. Tenth Edition. Pp. xiii+621. 16x23 cm. Cloth. 1911. Price, $5.50, net. P. Blakiston's Son & Co., Philadelphia.

Characteristics of Existing Glaciers. By William Herbert Hobbs, University of Michigan. Pp. xxiv+301. 15.5x22.5 cm. 1911. Cloth. $3.25, net. The Macmillan Company, New York.

The Social Evil in Chicago. By the Vice-Commission of Chicago, Dean Walter T. Sumner, Chairman. 399 pages. 16x24 cm. 1911. Gunthorp-Warren Company, Chicago.

Advanced Arithmetic. By Elmer A. Lyman, Normal College, Ypsilanti, Mich. 253 pages. 14x19 cm. American Book Company, Chicago.

Practical Methods in Arithmetic. By John H. Walch, Associate Superintendent of Schools, New York City. 395 pages. 14x19 cm. D. C. Heath & Co., New York.

Fundamentals of Agriculture. By James Edward Hallijan, Louisiana State Experiment Station. Pp. xiv+492. 15x21 cm. D. C. Heath & Co., New York.

How to Grow Vegetables and Garden Herbs. By Allen French. Pp. xxvi+312. 14x19 cm. 1911. $1.75, net. The Macmillan Company, New York.

High School and College Text-Books. Descriptive Catalogue and Price List. Pp. xxxviii+522. 1911. American Book Company, Chicago.

Problems and Questions in Physics. By Franklin T. Jones, University School, Cleveland. 58 pages. 13x19 cm. Paper. University Publishing Company, Cleveland.

Lectures on Fundamental Concepts of Algebra and Geometry. By John Wesley Young, University of Kansas. Pp. vi+247. 14x21 cm. Cloth. 1911. $1.60, net. The Macmillan Company, New York.

The Essentials of Psychology. By W. B. Pillsbury, University of Michigan. Pp. ix+362. 14x20 cm. Cloth. 1911. $1.25, net. The Macmillan Company, New York.

Proceedings of the Sixteenth Annual Meeting of the North Central Association of Colleges and Secondary Schools. Edited by Thomas A. Clark. 134 pages. 15x23 cm. Paper. 1911. Published by the Association. J. E. Armstrong, Treas. Englewood High School, Chicago.

Mathematics for the Practical Man. By George Howe, New York. Pp. vi+143. 13x 19 cm. Cloth. 1911. $1.25, net. D. Van Nostrand Company, New York.

First Year Mathematics for Secondary Schools. xii+365 pages.

Second Year Mathematics for Secondary Schools. xiv+282 pages.

Teacher's Manual for First Year Mathematics. vii+164 pages. All by George Williams Myers and Assistants, College of Education University of Chicago. All three books, 14x20 cm. Cloth. 1910. The University of Chicago Press.

The Teaching of Geometry. By David Eugene Smith, Columbia University. v+339 pages. 13.5x19 cm. Cloth. 1911.

Plane and Solid Geometry. By George Wentworth and David Eugene Smith. vii+470 pages. 14.5x19.5 cm. Cloth. 1911.

Vocational Algebra. By same authors. v+88 pages. 13x19 cm. Cloth, 1911. Ginn & Co., Boston.

An Introduction to Mathematics. By A. N. Whitehead.

Evolution. By Patrick Geddes and J. Arthur Thomson.

The Animal World. By F. W. Gamble. Each book 256 pages. 13x18 cm. Cloth. 75 cents, net. 1911. Henry Holt & Co., New York.

BOOK REVIEWS.

Essentials of Psychology, by W. B. Pillsbury, University of Michigan. Pp. xi+362. x cm. Cloth. $1.25, net. 1911. The Macmillan Company, New York.

In order that one be successful in almost any line of professional work one must have a good working knowledge of the fundamental principles of psychology. The business man must of necessity be able to incorporate into his processes those essentials of human actions which will enable him to secure the largest returns for the time and energy expended. No argument is necessary to prove that the instructor of any class or group of persons must be fairly well equipped with a good knowledge of the emotions which psychologically control those who come before him.

There is no better book written, treating on the fundamentals of psychology than this one of Professor Pillsbury. For the man of affairs, the professional man, or the person who wishes to come into closer touch with his fellows, this is the book for him to read and study. As a text-book it will be found interesting, teachable, and full of knowledge.

"Throughout emphasis has been placed upon fact rather than theory; where theories conflict the better one has been chosen. . . . The point of view is on the whole functional; more attention is given to what mind does than to what it is. With this goes an emphasis upon the outward manifestations of consciousness and upon the behavior of others to the subordination of the individual consciousness."

The matter discussed and the order of treatment is best indicated by giving the chapter headings which are as follows: "The Nervous System;" "Neural Action in Relation to Consciousness and Behavior;" "Sensation;" "Selection and Control;" " Retention and Association;" "Perception;" "Memory and Imagination;" "Reasoning;" "Instinct;" "Feeling;" "The Emotions;" "Action and Will;" "Work, Fatigue, and Sleep;" "Interrelations of Mental Functions;" "The Self."

Mechanically the book is well made, type large making it easy to read. The major paragraph begins with bold-face type. It is a work which will undoubtedly command an extensive circulation.

C. H. S.

Elementary Algebra, First Course, by John C. Stone and James F. Millis. Pp. v+307. 14x20 cm. 1911. Benj. H. Sanborn & Co.

Following the general plan of work adopted for their text-books in arithmetic and geometry the authors have prepared a first course in algebra combining the fundamental and necessary principles and methods of the older text-books with the present-day ideas of teaching secondary school mathematics.

The correlation of algebra with arithmetic and geometry has been thoroughly tested with satisfactory results in a number of schools, and in this book these branches are united in a way that will prove of advantage to pupils and teachers. Numerical problems are used to introduce literal expressions, and the principles and processes of arithmetic lead to the development of many principles and processes of algebra. Many problems are founded on the simple facts of geometry with which the pupils are familiar.

The old-time puzzles and complicated literal expressions have been eliminated, and the "informational" problems have happily in this book been made to approach the limit zero.

The real applied problems will interest the pupil and make him feel that algebra is of some use. The authors are not subject to the following criticism by an English writer. "We cannot imagine any English boy being

stimulated by such examples as: 'Silver is sold by the troy ounce. This is what per cent of the avoirdupois ounce (7000 gr. = 16 av. oz., 5760 gr. = 12 troy oz.)?' Or 'When Iowa's annual product amounted to 305,800,000 bu., this was how many times the 440,000 bu. produced by Maine?'" Perhaps the American boy thrives better than the English on such fare. It seems as though the American teacher has yet to learn that the phenomena of our daily existence, our simplest acts and experiences, present a rich field for those seeking for quantitative problems which will enliven the arithmetic lesson, quicken the intelligence of the pupil, and lead him to feel that his school arithmetic is intimately associated with the world in which he lives and acts.

While the book contains a minimum of theory and a maximum of practice, abundance of drill is provided. At all times the pupil is introduced to only one difficulty at a time, and this difficulty is conquered by copious drill before another one is presented. The book appears to be well balanced and teachable, and will undoubtedly find place in many schools.

H. E. C.

The Pupils' Arithmetic, by James C. Byrnes, Member of Board of Examiners, Department of Education, Julia Richman, District Superintendent, and John S. Roberts, Principal of Public School 62, Manhattan New York. Book Three. Pp. viii+256. 13x19 cm. 35 cents. Book Four. Pp. viii+235. 13x19 cm. 35 cents. 1911. The Macmillan Company.

Book Three covers the work in arithmetic of the fifth school year in all parts of the United States, and also includes some of the work of the sixth year in those schools in which there is a more restricted range of topics for the fifth year. It contains a review of the fundamental operations, properties of whole numbers, a full treatment of common fractions and decimal fractions, and a brief treatment of the reduction of denominate numbers, the mensuration of rectilinear figures, and an introduction to percentage.

Book Four contains a review of the fundamental operations, common fractions, and decimal fractions, a summary of the work in denominate numbers, a comprehensive treatment of percentage, and a less extended treatment of simple interest.

The four books in this series offer a large number of exercises for rapid drill work as well as a large number of simple practical problems relating to daily life with which the children are familiar. The exercises and problems are carefully graded, and long numbers, lengthy processes, and unfamiliar conditions in problem work have been avoided. Though the topics of the previous grade are reviewed in the opening work in each book, the authors have adopted the plan of a full treatment for each topic rather than the spiral treatment.

H. E. C.

Advanced Arithmetic, by Elmer A. Lyman, Professor of Mathematics in the Michigan State Normal College, Ypsilanti. Pp. 253. 13x19 cm. 1911 American Book Company.

This book is intended for pupils who have completed grammar school arithmetic. It aims to develop fundamental principles and to make the pupils familiar with the essentials of commercial practice. Most of the exercises have been selected from actual business transactions, and short processes and methods of checking results are emphasized.

The historical notes are well presented and should arouse the interest of teachers and pupils in the development of arithmetic.

The use of squared paper in representing tables of values and in solving problems is given a brief but clear treatment which, and it should, impress teachers with the value of the graphical method of solving problems.

It is interesting to note that more attention than usual is given to a discussion of approximate results, and the proper method of using approximate numbers in calculations. Not only in "scientific investigations" but also in the daily work of men and boys in shops or wherever measurements are made is it rarely possible to obtain exact results. Hence it seems worth while to teach methods of calculation which shall give results agreeing with the data in degree of accuracy. The author, however, has not always been careful to make his results correspond in accuracy with the data. A four-place table of logarithms gives results which should be carried out to only four significant figures.

Because of the wise selection of material, the careful development of fundamental principles and the clear explanations of methods and processes this book will be used in many schools.

H. E. C.

Practical Methods in Arithmetic, by John W. Walsh, Associate Superintendent of Schools in the city of New York. Pp. iv+395. 13x19 cm. 1911. D. C. Heath & Co.

In this book the author presents methods for teaching the topics that in his opinion properly belong to the mathematical courses of the eight years of the elementary school. One or two sentences in the introduction indicate the plan and scope of the book. "The following pages are intended to show the simplest way of teaching arithmetic, and that the simplest way is the most scientific one. Although the suggestions are presented in plain language, carefully avoiding the employment of the technical terminology of pedagogy and of psychology, the opinions of the authorities on mathematical teaching are carefully followed. . . . . The methods recommended are not the only good ones, nor are they given in great variety. The thoughtful teacher in his reading will discover many others, some of which may seem better suited to his case."

In the first part suggestions are given on the course of study, forms of exercises, the recitations, and general suggestions. In the second part the work of the first four years, in the third part of the work of the fifth and sixth years, and in the fourth part the work of the seventh and eighth years is considered.

In the appendix is an excellent discussion of equational arithmetic, construction exercises, and the metric system.

This book should be heartily welcomed by all teachers of arithmetic. It is evident that the author is thoroughly acquainted with the subject, and he calls attention to the good and bad points in various methods in a very interesting and forceful way. His suggestions if followed would greatly increase the efficiency of instruction in arithmetic.

H. E. C.

Second Course in Algebra, by Herbert E. Hawkes, William A. Luby, and Frank C. Touton. Pp. vi+264. 13x19 cm. 75 cents. 1911. Ginn & Co.

The opening chapters of this book give a thorough review of the work covered in the first course. Nonessentials are omitted and the topics are presented in a form suited to the increased ability of the pupils. Since new material is used and many new applications are given this review work will prove interesting to the pupils. Problems relating to motion, velocity, levers, beams, and so on furnish many applications of familiar principles; and the pupils' knowledge of geometry will be used to advantage in the large number of geometrical exercises.

The subjects which are not given in the first course are treated in the same practical and perspicuous manner. Considerable use has been made of the graph to solve problems as well as to illustrate principles; and determinants are used freely in the solution of systems of equations. The biographical and historical notes are well chosen, and present vividly important facts in the development of mathematics.

The chapters on progressions, limits and variables, and ratios, proportion and variation are especially well written. It can be safely said that the authors have achieved their purpose to produce a text that is modern, lucid, mathematically correct and interesting.

H. E. C.

Fundamentals of Agriculture, edited by James E. Halligan, La. State Exp. Sta. Pp. xiv+492. 1911. D. C. Heath & Co.

This book departs from the usual type in text-books in that it is the work of a large number of authors, some thirty names being represented in the table of contents. It is claimed for the book that this arrangement secures expert authorship of every chapter, and it certainly gains in authority thereby. As a compendium of information on agricultural topics it is excellent and is bound to be much used for reference.

As a text-book it has the faults which go with such divided authorship. The treatment of each topic is excellent, though often showing evidence of compression where elimination would have been better; the book as a whole fails to show the careful organization which might be expected if it were the work of a single author. This does not mean that it is not useful as a text-book, but only that perfection is not yet attained. Perhaps in the present condition of secondary instruction agriculture, only a book with wide range in selection of materials would meet the needs of the case. At any rate, in the hands of a teacher who has the ability to organize his own course, this will be a very acceptable class book. The extensive lists of references are particularly useful.

There are some evidences of too great haste in going to press such as the inverted cuts on pages 25 and 28, and a considerable number of misprints. There are also a number of cuts in which the reproduction is so unsatisfactory that the point is wholly obscured, as on pages 16, 21, 78, 112, 194. Numbering of the sections and figures in the usual way would have been a convenience in class room use.

Evolution, by Patrick Geddes and J. Arthur Thomson. xiv+256 pages. 13x 18 cm. Cloth. 1911. 75 cents. Henry Holt & Co., New York.

What was said in the first paragraph of the preceding review will apply equally well to this book. It is splendidly written and will give the lay reader a broad and well-defined conception of what evolution really is from the point of view of the true scientist. The book will do much to banish the bigotry which now exists on the subject in the minds of many persons. The reader cannot help being richly benefited by the reading of the book.

The subject-matter is discussed under these heads: Chapter I. "Evidences of Evolution from Explorer and Palæontologist." II. "Evidences of Evolution from Anatomist, Embryologist, and Physiologist." III. "Great Steps in Evolution." IV. "Variation and Heredity." V. "Selection." VI. "Organism, Function, and Environment." VII. "Evolution Theories in Their Social Origins and Interactions." VIII. "The Evolution Process Once More Reinterpreted." There is a bibliography of eight pages. These books should be in every private library.

C. H. S.

High School and College Text-books. Descriptive catalogue and price list. Pp. xxxviii+522. 14x19 cm. Cloth. 1911. American Book Company, Chicago.

This catalogue is one of the most comprehensive which the writer has been privileged to see. It is made like a real book, indeed it is one and may be used as such. It describes briefly, but perfectly, clearly each one of the many publications of this firm. A person reading these descriptions will get a good knowledge of the general character and scope of the various texts. In addition to this method of bringing the nature of the books before the reader, there is given, in nearly every case, several comprehensive testimonials from teachers and users of the particular books. There is a complete index of the publication of this firm together with a price list and code word which may be used in ordering; following this there is given a list of the books recently published.

This catalogue will be a valuable aid to teachers and superintendents in selecting texts for use in their classes and schools. Teachers will appreciate this splendid book, which will undoubtedly materially assist in increasing the sales of the publications of this firm. It is a work such that we will not be ashamed to place it among the reference books of his library. The production of such a catalogue shows the commendable enterprise of this company and reflects, too, the character of the books which they publish.

C. H. S.

The Social Evil in Chicago. A study of existing conditions with recommendations, by the Vice-Commission of Chicago, Dean Walter T. Sumner, Chairman. 390 pages. 16x24 cm. Gunthorp-Warren Printing Company, Chicago.

On January 31, 1910 a meeting of the Church Federation, composed of clergymen representing over six hundred congregations of Chicago, assembled at the Central Y. M. C. A. Auditorium to listen to the discussion of a paper on "The Social Evil Problems in Chicago," by Dean Sumner.

At the conclusion of the meeting he presented a resolution to the effect that the mayor be asked to appoint a committee, consisting of representative men and women, to investigate the conditions of this social evil in Chicago and make a complete report. This resolution was unanimously adopted and a committee was appointed to call upon the mayor and present it to him for his consideration. As a result, the mayor appointed a committee of thirty men and women representing institutions and factors standing for the highest type of morality and civic righteousness, to investigate thoroughly these evil conditions as they exist in Chicago. The committee organized by electing Dean Sumner, chairman, and Edwin W. Sims, secretary. Subcommittees on the following topics were appointed: Existing Conditions in Chicago; Social Evil and Saloon; Social Evil and Police; Sources of Supply; Social Evil and Crime; Child Protection and Education; Rescue and Reform; Literature and Methods; Medical Questions, and Law and Legislation.

These committees immediately began work making one of the most complete and thorough investigations of the kind ever undertaken in any city. Their report was presented to the mayor, April 5, 1911.

Too much cannot be said in commendation of this splendid report. The conditions it reveals are appalling. The saloon evil, bad and degrading as it is, bears no comparison with the awful and disgusting conditions which exist under this social abomination. This report ought to be read carefully from cover to cover by every man and woman of strong moral character in order that their eyes may be opened to the terrible condition which prevails probably in every large community.

It is time when prudishness and so-called modesty be banished and our boys and girls, especially in our secondary schools, be taught something concerning how the race is propagated. It is more important that the boy and girl know something about the physiology and hygiene of the sexual organs than it is to have a knowledge of the functions of the heart or stomach. The boy and girl is sure to gain some kind of a knowledge of these matters and if they do not get it in the proper manner it will come by the way of the street and companions of evil thoughts and actions. The writer recently had a Wednesday evening class of some 50 high school and working boys of an average age of over 18 years. Social and civic questions were discussed. These boys came from highly-cultured homes and those of refinement, yet when the question was asked: "How many of you were taught by either father or mother about your sexual organs, their care and abuse?" only six out of thirty-five said that they learned these matters from their parents. This shows a deplorable lack of judgment on the part of American parents, because what was true in this, more than the average condition is, undoubtedly true in a greater sense in other communities.

This journal stands for the highest kind of manhood and womanhood and is trying to assist in bringing the condition about by advocating in its columns that kind of instruction, which not only educates intelligently but morally as well. For the last two years it has printed many articles on the subject of "Instruction in Social Hygiene in the Public Schools." It is through the proper instruction of our children in these matters that the disgusting conditions exhibited by this report are to be finally and absolutely exterminated.

Legislation against the social evil is all right and proper, but until a stronger public opinion is created in opposition to it, no permanent elimination of the abomination will be obtained. It is through education of our boys and girls in their teens and the revelation to men and women of the disgusting and filthy conditions which exist in populous centers that this blot on our civilization will be entirely eradicated.

C. H. S.

The Animal World, by F. W. Gambble. xii+256 pages. 13x18 cm. Cloth. 1911. 75 cents. Henry Holt & Co., New York.

This book is one of the second set of the Home University Library which this firm is now putting on the market. Fundamentally this set gives an epitome of the knowledge of the subject upon which each particular book treats. The books are not intended for use by the specialist in the subject but were written primarily for the layman and person who writes to secure information upon the latest thought and research of the subject discussed. They are intended for adult rather than younger readers. The matter is thoroughly dissected and comprehensively centered upon a few of the more interesting and important phases of the animal world.

The book is divided into ten chapters with topics as follows: I. "The Structure and Classification of Animals." II. "The Movements, Succession, and Distribution of Animals." III. "The Quest For Food." IV. "How Animals Breathe." V. "The Colors of Animals." VI. "The Semes of Animals." VII. "Societies and Associations." VIII. "The Care of the Young." IX. "Life History of Animals." X. "Heredity and Variation." The volume contains a complete bibliography of the best books relating to the subject. The book is written in such a manner that the reader will at once become interested, his attention being closely held through the entire reading. It will, in many minds, undoubtedly stimulate a desire for further thought and study.

C. H. S.

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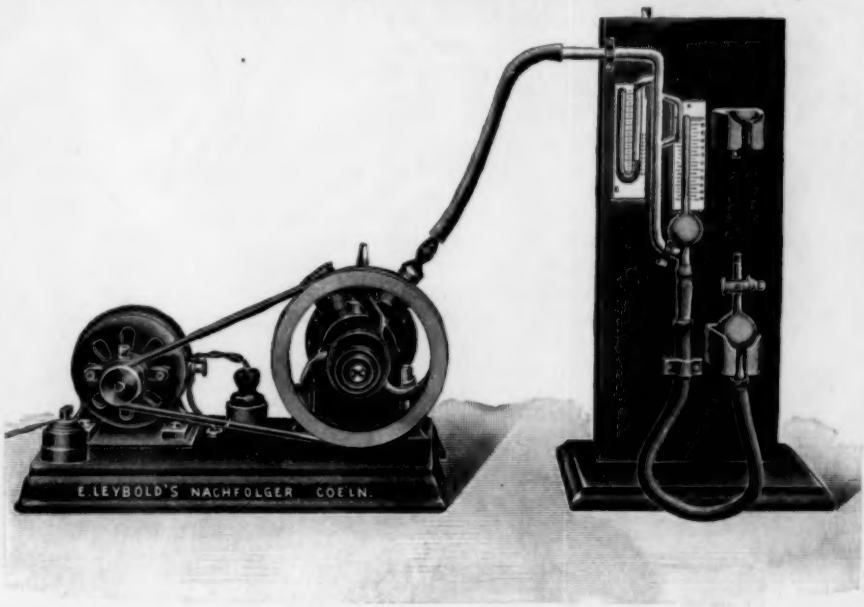

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A Systematic Handbook of Volumetric Analysis; or the Quantitative Determination of Chemical Substances by Measure, Applied to Liquids, Solids, and Gases, by Francis Sutton. Tenth edition, revised throughout, with numerous additions, by W. Lincolne Sutton and Alfred E. Johnson, Philadelphia. Pp. 621. Price, $5.50, net. 1911. P. Blakiston's Son & Co.

In this edition much obsolete matter of the previous one is omitted, a new type has been selected, and all references carried to the foot of the page.

Although much new material has been added, the book contains few more pages than the ninth edition and in general its nature is the same.

The International Atomic Weights for 1911 have been adopted and all factors, numerical examples, etc., recalculated accordingly.

The sections on the pipette, the measuring flask, and weights and measures, have been entirely rewritten, that on indicators enlarged, while in Part III, Analysis by Oxidation and Reduction, the introductory portion is rewritten and the whole somewhat amplified.

Part IV, Analysis by Precipitation, is short and but few alterations noted, but in Part V the changes are numerous including many new processes, Knecht's titration of iron by titanous chloride, Ling's method of using Fehling's solution, etc.

In Part VI, on Analysis of Urine, Potable Waters, Sewage, etc., Liebig's method of determining urea is omitted and that by Gerrard is described.

The section on Gas Analysis shows little material change. A book that comes to its tenth edition as well prepared as Sutton's Volumetric Analysis is sure to afford satisfaction to its many users.

Very few typographical errors were noted.

A. L. S.

How to Grow Vegetables and Garden Herbs, by Allen French. Pp. xxvi+312. 14x19 cm. 1911. Cloth. $1.75, net. The Macmillan Company, New York.

This is a new edition of the book published under the head of "The Book of Vegetables" and is written for the purpose of giving assistance to all who have anything to do with vegetable seeds, either as buyers or sellers. It is divided into three parts, the first consisting of general epitome of vegetable growing and cultivation, the second headed "planting table" constitutes the body of the book, the third discusses briefly seed-longevity and ounce values.

In the second part, the best method of how to raise practically all the herbs and vegetables which will grow in this country is described. Under the teaching of each plant the method of cultivation is given in the following order: Short description of plant; soil best adapted for its growth; distance of plants apart; depth to plant seed or set root; when and how to sow under glass; when and how to sow out of doors; how many plants in a hill; when and how to transplant; method of culture; kind and quantity of fertilizer to use; how to, and when to begin training or tying; when to cut or pick; how to winter; diseases and how to remedy; pests and how to exterminate. The process of raising certain plants, however, is discussed under heads peculiar to those plants. In part two the plants are arranged in alphabetical order for discussion. The index is complete, making it easy to locate the discussion of any particular plant. There are 144 cuts and illustrations. The type is large and the matter well arranged. The mechanical work of the book is well done. It deserves a wide circulation and will undoubtedly secure it as there is nothing better of the kind printed in English.

C. H. S.

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Problems and Questions in Physics, by Franklin T. Jones, University School, Cleveland. 58 pages. 13x19 cm. Paper. University Publishing Company, Cleveland.

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Fundamental Concepts of Algebra and Geometry, by J. W. Young, Professor of Mathematics in the University of Kansas. Pp. vi+247. 14x20 cm. $1.00. 1911. The Macmillan Company.

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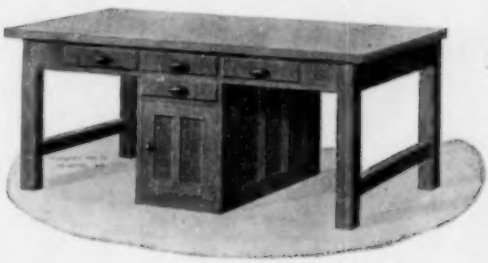

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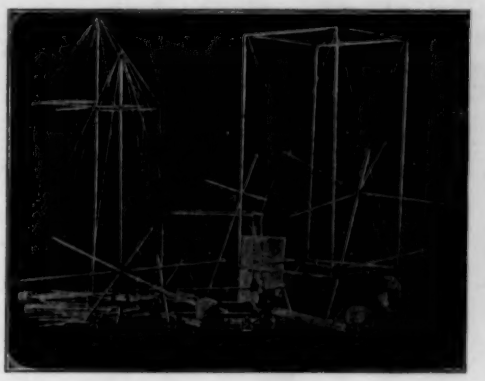

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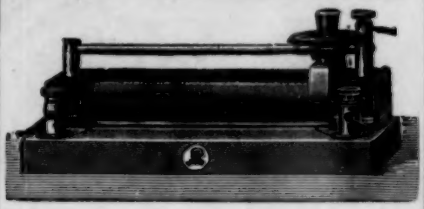

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